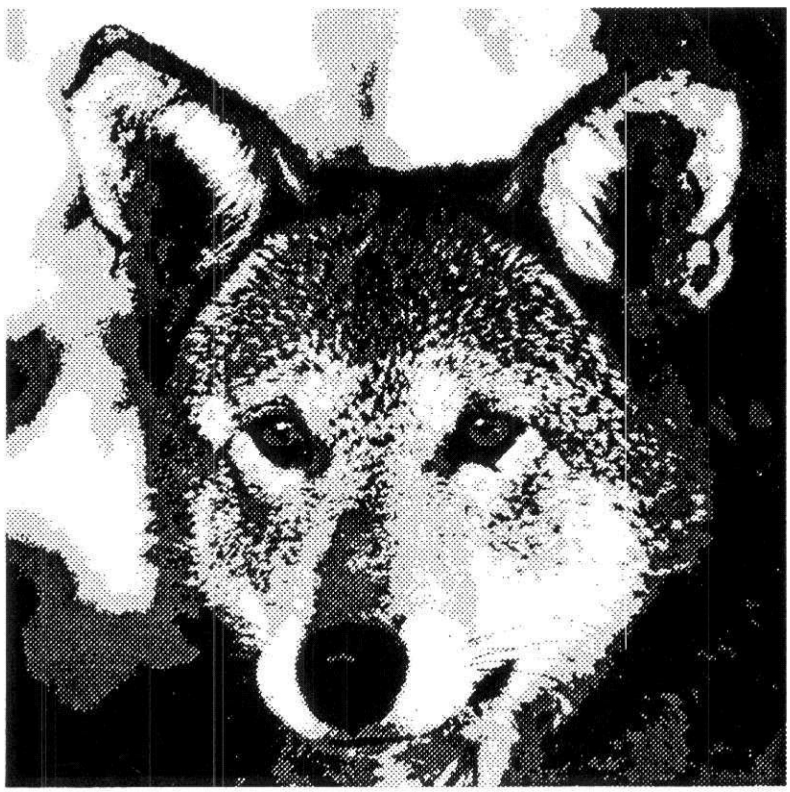
Red Wolf

Recovery/Species Survival Plan



Canis rufus

U.S. Fish and Wildlife Service

RED WOLF RECOVERY PLAN

(Original Approved: July 12, 1982)

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for
Southeast Region
U.S. Fish and Wildlife Service
Atlanta, Georgia

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Approved: ______________________

Date: October 26, 1990

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1989. Red Wolf Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 110 pp.

Additional copies of this plan may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
Phone: 301/492-6403 or
1-800/582-3421

The fee for a plan varies depending on the number of pages in the plan.

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EXECUTIVE SUMMARY FOR THE RED WOLF RECOVERY PLAN

Current Status: This species is listed as endangered. Although thought to be extinct in the wild by 1980, recent recovery efforts have placed small numbers of red wolves at four locations within the species' historic range. One is a major reintroduction site in northeastern North Carolina, and the other three are island propagation projects. At the present time there are 135 red wolves in existence--115 in various captive facilities and 20 in the wild.

Habitat Requirements and Limiting Factors: Large areas of habitat of at least 170,000 acres in size are required by this species, preferably dedicated units of National Wildlife Refuge lands and National Park Service properties. The absence of coyotes is preferable, but low to moderate populations of these competitors should not exclude an area from consideration. Human attitudes regarding wolves are probably the most significant single factor involved in recovery planning for these animals.

Recovery Objective: The establishment of 220 red wolves in wild situations and the maintenance of 330 in captivity would provide for genetic stability and maintain the species. For the foreseeable future it is not considered feasible to either delist or downlist this species.

Recovery Criteria: Establish and maintain at least three reintroduction projects within the historic range of the red wolf. This must be paralleled by the cooperation and assistance of at least 30 captive-breeding facilities in the United States. Human attitudes regarding red wolves must be addressed through education processes.

Actions Needed:

1. Maintain and evaluate existing wild populations.
2. Establish new populations in the wild.
3. Expand captive-breeding capabilities.
4. Expand cryopreservation capabilities.

Costs ($000's):

Year	Need 1	Need 2	Need 3	Need 4	Total
1990	195.0	50.0	188.0	12.0	445.0
1991	225.0	230.0	208.0	10.5	673.5
1992	368.5	300.0	260.0	20.0	948.5
1993	400.0	250.0	200.0	20.0	870.0
1994	500.0	150.0	200.0	10.0	860.0
1995	500.0	100.0	100.0	10.0	710.0

Date of Recovery: A reassessment of the red wolf recovery program should be made in 1995, and more realistic projections should be formulated then.

PREFACE

The red wolf (Canis rufus) was one of the first endangered species to attract recovery attention by the U.S. Fish and Wildlife Service (Service) after the passage of the Endangered Species Act on December 28, 1973. An interim recovery team was appointed on August 4, 1974, and in January 1975, it received official sanction by the Service.

By mid-1975 it became apparent that the only way the red wolf could be saved from extinction was to capture as many wild animals as possible and place them in a secured captive-breeding program.

In July 1982, a Red Wolf Recovery Plan was approved by the Director of the Service. This plan was revised, updated, and approved on September 18, 1984. The original recovery team was disbanded, and a new team was appointed by the Southeast Regional Director of the Service in 1986.

A major step toward recovery for the species has been the apparently successful reintroduction of wolves at the Alligator River National Wildlife Refuge in 1987. Some of these captive-born-and-raised animals are adjusting to a wild environment and have reproduced in the wild. Considerable public interest in the plight of the red wolf and reintroduction attempts has developed.

In May 1988, Service officials met with genetic and demographic specialists in Apple Valley, Minnesota, to develop population goals for the red wolf. Because captive breeding has played such a decisive role in the survival of the species, it was determined that a completely revised Red Wolf Recovery Plan should be integrated into a Species Survival Plan (SSP). A Species Survival Plan is the zoological community's plan for addressing biological and organizational questions regarding long-term propagation of an endangered species. Species survival planning is done under the auspices of the American Association of Zoological Parks and Aquariums (AAZPA).

This combined plan is therefore intended to serve as a guide that delineates and schedules actions believed necessary to restore the red wolf as a component of certain ecosystems within the Southeastern United States. It is a multifaceted plan, incorporating captive-breeding objectives as well as reintroduction and propagation-in-the-wild strategies.

Red wolf reintroductions into the wild will entail coordinated and cooperative efforts from many local, State, and Federal entities and national environmental organizations, as well as the cooperation of private and corporate landowners in many areas of the Southeast.

Complete species recovery permitting delisting will probably never be achieved for the red wolf. It is realistic, however, to restore carefully managed disjunct populations within portions of its historic range and to secure the genetic integrity of the species. Addressing 1988 recovery amendments to the Endangered Species Act becomes difficult in light of specific obstacles that will surely frustrate red wolf recovery objectives. Defining those monetary and time requirements that would be represented as achieving delisting depends to a great extent on the success of a current experimental release of red wolves into the Great Smoky Mountains National Park in western North Carolina and eastern Tennessee. If this study demonstrates that red wolves successfully compete with resident coyotes, then objectives as set forth in this plan can likely be achieved. If, however, it becomes evident that the two wild canids exhibit social interactions and interbreeding, then the fate of the red wolf will likely rest with island sanctuaries where the genetic integrity of Canis rufus can be maintained only through long-term management.

PART I

INTRODUCTION

The primary long-range goal of the Red Wolf Recovery Program has always been to reintroduce this extinct-in-the-wild species into portions of its historic range. The red wolf has been characterized by several writers as the "Flying Dutchman" of the wildlife world--a species without a safe haven since the early 1970s. This plan is prepared in an effort to bring forward the latest information available on the historical status of the species, the various factors that led to its ultimate demise in the wild, and the planning being made to recover this unique animal in portions of its historic range.

Historic Overview

The Genus Canis in North America

Taxonomists generally agree that there are three living species of wild *Canis* in North America--the coyote (*C. latrans*), the gray wolf (*C. lupus*), and the red wolf. The gray wolf is circumpolar in distribution and is represented by over 30 subspecies worldwide. This robust animal once occurred throughout North America, represented by 24 subspecies whose range extended from Southern Mexico northward to Greenland and Ellesmere Island (Hall and Kelson 1959). The coyote was originally found throughout most of the western half of North America, and in the last 40 years its range has been expanding eastward. The red wolf appears to be a species that, for a variety of factors, was adapted to the Southeastern United States.

Taxonomic Status of the Red Wolf

The canids of the Southeast have been assigned various scientific and common names, primarily by people who had not closely studied the animals. Bartram (1791) first described the red wolf in Florida, but writings dating back over 300 years mention wolves throughout the Southeastern United States, from central Texas to Florida and north to the Ohio River Valley. Audubon and Bachman, in their classic work (1851), were the first to suggest that in the southern states there existed a wolf that was structurally different from other wolves they had seen. They described the "Black American Wolf" as occurring only in Florida, South Carolina, North Carolina, Kentucky, southern Indiana, southern Missouri, Louisiana, and northern Texas. They also discussed the "Red Texan Wolf," which they thought ranged from northern Arkansas through Texas and into Mexico, but believed all the wolves they described were only varieties of one species.

Unfortunately, the red wolf was exterminated from most of its range by the early part of this century (Nowak 1972). Few specimens were preserved, and there were no definitive descriptions of the animal's appearance or life history. Because of this, we know little of the animal under natural conditions. During the late 1800s and early 1900s significant revisions were initiated in the taxonomy of this unique wolf. Bangs (1898) determined that the Florida wolf should be elevated to full species level (*Canis ater*), while Bailey (1905) elevated Audubon and Bachman's "Red Texan Wolf" to a full species as *Canis rufus*. Bailey assigned this new species to a range in southern and central Texas. Vernon Bailey was the chief field naturalist of the U.S. Biological Survey (predecessor of the Service) and was the first knowledgeable biologist to examine the wild canids of Texas. He found the small red wolf of the south-central part of the State to differ so greatly from the larger gray wolf of the plains just to the west that the two deserved to be treated as completely different species. Miller (1912) designated the Florida wolf as *Canis floridanus*, which generally became accepted for all wolves in the forested areas of the Southeastern United States, while *C. rufus* continued to be recognized in central and southern Texas (Nowak 1979).

Years later, Edward A. Goldman (Goldman 1944), senior biologist with the U.S. Biological Survey, examined a larger number of canid specimens and found that the Texas red wolf intergraded in characteristics with the canids across the Southeastern United States to Florida, including a continuity of key cranial and dental features. Goldman thus consigned all of the wolves of the Southeast to one species, *C. rufus*. By the time of the publication of this revisionary work in 1944, the red wolf had already been extirpated east of the Mississippi River. Goldman listed *C. r. rufus* for the small Texas subspecies, *C. r. floridanus* for the eastern subspecies, and *C. r. gregoryi* in the lower Mississippi Valley. Goldman's nomenclature persists to the present time (see Plate 1).

Later investigators have generally supported Goldman's classification. An exception to this is Lawrence and Bossert (1967), at Harvard University, who performed a multiple character analysis of North American *Canis*. This study involved carefully measuring a series of skulls and subjecting the resulting figures to numerical analysis by computer. The skulls included those of 20 gray wolves, 20 coyotes, 20 domestic dogs (*C. familiaris*), and a small number of red wolves collected before 1920. The results of their study suggested that the red wolf was close enough to the gray wolf to be considered only a subspecies of the latter (Lawrence and Bossert 1967).

Paradiso (1968) and Nowak (1979) suggested that Lawrence and Bossert's sample size had been too small and did not truly represent the great geographic and individual variation of the canids. Paradiso and Nowak (1971) sampled a large number of skulls of *C. rufus*, *C. lupus*, and *C. latrans* and concluded that the red wolf was a distinct species.

Plate 1. Map showing localities of *C. rufus* from archeological sites (triangles), and fossil *C. rufus* (black dots). The solid lines show the distribution of subspecies: *C. rufus rufus* (R), *C. rufus gregoryi* (G), and *C. rufus floridanus* (F). Because of scale of map, it is not possible to plot all localities in crowded areas. (From NOWAK: 1979).

Later, Nowak (1979), in examining the systematic problems in the genus Canis in North America, conducted multivariate analyses on approximately 5,000 canid skulls. His conclusions, as well as those of Kurten and Anderson (1980), agree in the probable derivation of the red wolf from a coyote/wolf ancestor and a later separation of the gray wolf, which entered (or reentered) North America at a later date. Nowak (1979) expressed his conclusion as follows:

> "In nearly all measurements and other features in which C. rufus differs from C. lupus, the former approaches C. latrans. Indeed, available specimens of the red wolf almost bridge the morphological gap between the proximal extremes of the other two species. Hybrid origin for C. rufus thus seems to be one possibility, but there are other solutions to the problem. The most reasonable explanation is that C. rufus represents a primitive line of wolves that has undergone less change than C. lupus, and has retained more characters found in the ancestral stock from which both wolves and coyotes arose."

In later assessing these conclusions, Nowak (1989) reaffirms his position:

> "That last particular statement reflects one of the positions in my dissertation about which I feel most confident. The original characters of C. rufus can be traced back long before hybridization would have begun, even into the Pleistocene. C. rufus did not have a hybrid origin, but it does retain ancestral features, and thus it is morphologically shifted away from C. lupus in the direction of C. latrans."

It is significant to note that Nowak (1989) continued his line of thought by commenting that his above-referenced conclusion:

> "...does not necessarily mean that C. rufus is a distinct species. One could argue that, while C. rufus is primitive, C. lupus never became completely isolated from it genetically, and that the two were blending to some extent where their ranges met in North America. Unfortunately, there are very few specimens from appropriate times and places. My own samples showed so little overlap that I considered it best to treat the two as distinct species."

In a comparative gross morphological study of the cerebellum in six species of Canis, Atkins and Dillon (1971) confirmed the distinct speciation of C. rufus and concluded that, while the red wolf is most closely related to C. lupus in its cerebellar features, it appeared to be more primitive in several aspects than any of the other species of Canis considered. A related study of canids from Missouri by Elder and Hayden (1977) demonstrated, by multivariate analysis of skulls collected, a complete separation of coyote, dog, gray wolf, and red wolf. This investigation also revealed that during the 1940s and 1950s there was an infusion of red wolf genes into the coyote population as the red wolf was being exterminated in Missouri. This information reinforces conclusions reached later by Nowak (1979) and other researchers.

In a December 7, 1981, letter from Donald C. Morizot (1981), a researcher at the University of Texas System Cancer Center, to Service biologist Curtis J. Carley, Morizot set forth some of the findings of his biochemical-genetic study of the evolution of canid species. He stressed the fact that few biochemical-genetic differences among living *Canis* species have been discovered. Morizot's study (unpublished data), however, did detect "substantial genetic variation at three enzyme loci" in red blood cell samples in comparisons of dogs, coyotes, red wolves, and gray wolves. Samples of red wolf blood cells examined resulted in an allele not seen in any other *Canis*. He concluded that the red wolf is genetically more similar to the coyote than the gray wolf but possesses an allele unknown in coyotes. Additional data derived from skull measurements of red wolves and coyotes in early collections convinced him of the integrity of the red wolf as a separate form which should be recognized as a small wolf which evolved in North America.

After Lawrence and Bossert (1967) published their contention that the red wolf should be treated as a subspecies of the gray wolf, other investigators have supported their findings, including Mech (1970). It is interesting to note that the literature is not consistent in the ancestral relationship of *C. rufus* in the genus *Canis*, even among those investigators who support speciation. While Lawrence and Bossert (1967) and Atkins and Dillon (1971) differ on the question of speciation, both consider the red wolf to be closely allied to *C. lupus*. Conversely, both Nowak (1979) and Morizot (1981) support speciation but consider the red wolf to be more closely related to *C. latrans*.

At the time of this writing, efforts are underway to critically assess biochemical variations within the wild canids of the United States utilizing the latest techniques in analyzing blood chemistry and DNA. It will probably be several years before definitive information is available to either support or reject the issue of speciation based on these tests. It should be noted, however, that all factors, including morphological and others, will have to be weighed in making any determination of speciation. No one single test can be relied on in addressing this important concern. In the interim the words of Clutton-Brock (1989) serve to guide red wolf recovery efforts:

> "I very much hope that you will be successful in your efforts to conserve the red wolf, which (whether it is called a race of *Canis lupus* or a distinct species of wolf) is clearly a distinctive wild canid that is in severe

danger of extinction and whose demise would mean a severe loss of biological diversity within the dwindling groups of large carnivores."

The Service recognized the red wolf as a species in listing it as an endangered species in 1967 (32 FR 4001). Subsequent Federal Register notices regarding the red wolf include 1979 (44 FR 29571), 1980 (45 FR 33768-33781), and 1986 (51 FR 41790-41796).

Human Conflicts

When the first American settlers arrived in what are now the Southern Atlantic States, they typically brought with them a deeply rooted European fear and hatred for wolves. Many of these Old World attitudes were founded on an animal that may have been more aggressive than its North American counterpart. Whether more aggressive or not, these Old World fears centered on the wolf as being not only a menace to farm and flock, but also in league with the Devil. Greek and Roman literature relate that men became wolves. In the fifteenth century a council of theologians determined that werewolves did exist (Young 1944).

With these ingrained fears, it is little wonder that New World wolves were pursued with a vengeance, and indeed, by 1920 *C. r. floridanus* was extirpated in the Southern Atlantic States. The species, by this time, had also vanished from southeastern Kansas and central Oklahoma and from much of its former range in Texas. By the late 1930s it is thought that only two viable concentrations of red wolves existed. One was located in the Ozark/Ouachita Mountain region of Arkansas, eastern Oklahoma, and southern Missouri, and the other was in the still extensive river bottom forests and coastal regions of southern Louisiana and southeast Texas (Nowak 1972).

Demise of the Species

Man played the major role in the extinction of the eastern subspecies of red wolf, *C. r. floridanus.* Fear and a gross misunderstanding of the animal led to early bounties and indiscriminate killing. Secondary impacts by man included extensive land-clearing and drainage projects during the early 1900s. The advent of World War I, with resultant logging and mineral exploration and road development, opened up last vestiges of once remote habitat and probably was the final blow that eliminated *C. r. floridanus.* These developments probably had similar impacts on other large predators, including the Eastern cougar (*Felis concolor cougar*) (U.S. Fish and Wildlife Service 1981).

These conditions paralleled the decline of deer herds and other forest wildlife prey which could have affected red wolf populations. It is probably no coincidence that deer herds in the Southeast reached an all-time low around 1920 (Barick 1951)--a date that approximates the extinction of *C. r. floridanus.* With deer numbers at all-time lows, wolves were probably forced into closer contact with man and agricultural lands which typically harbored small prey species such as rabbits. Free-ranging livestock undoubtedly attracted some wolves with resulting wolf-related losses. All of these factors contributed to intensified predator control efforts.

Beginning around 1920, enough forest habitat had been cut over in eastern Texas and Oklahoma to intensify an eastward surge by *C. latrans.* This adaptable species responded for reasons that go beyond changes in land use. It appears that for thousands of years *C. latrans* and *C. rufus* existed along a north-south line that roughly bisected Texas and Oklahoma. As predator control efforts became more efficient, the larger and more easily caught red wolf (Pimlott and Joslin 1968) was totally removed from extensive areas, while in other areas its social structure was destroyed. Into these vacated habitats moved *C. latrans* (Paradiso and Nowak 1971). Over the years the situation became more and more threatening for the red wolf, and the possibility that the species was in danger of extinction was finally noted by McCarley (1962).

Paradiso and Nowak (1971), in reviewing the circumstances that led to the decline of *C. r. rufus* and *C. r. gregoryi,* pointed out that red wolf museum specimens collected west of the Mississippi River after the 1930s were much smaller than those collected prior to the 1930s. These they describe as a "different kind of canid." This situation was especially prevalent in northeast Texas, southern Louisiana, and portions of Arkansas where significant morphological diversity of representative canids indicated hybridization between red wolves and coyotes. This did not appear to be true in Oklahoma and Missouri where *C. latrans* simply replaced *C. rufus* as a result of effective control efforts.

By 1972, the range of the red wolf was eroded to a small coastal unit that included parts of Liberty, Chambers, Jefferson, Brazoria, Galveston, and Harris Counties in southeastern Texas, and Cameron and Calcasieu Parishes in southwestern Louisiana (Riley and McBride 1972). Here the red wolf continued to be menaced by man and an ever-expanding coyote population that threatened to overwhelm the species unless dramatic actions were taken.

The Recovery Program

In anticipation of the passage of the Endangered Species Act, the Service established a formal recovery program for the red wolf in the fall of 1973. Responsibility for the program was assigned to the Texas office of the Service's Division of Animal Damage Control in San Antonio, Texas, with Curtis J. Carley the program project leader. A Red Wolf Recovery Program office was established in Beaumont, Texas, near the center of the remaining range of the species. With the field program for the red wolf already underway, the Endangered Species Act was passed on December 28, 1973.

The recovery program was established on the basis of information indicating that a pure population of red wolves still existed in southeast Texas and adjacent areas of Louisiana. However, field work soon demonstrated that a "hybrid coyote-wolf swarm" had formed, first in central Texas and then spreading eastward (Carley 1975). This extensive hybridization apparently occurred only in the east-central Texas portion of the species' historic range (Paradiso and Nowak 1971). Among the canids of the area, wolves appeared to be in the minority. As a consequence of this finding, the recovery program was redirected from an objective of local preservation to one of planned extirpation of the species in the wild. However, the decision to remove the last red wolves from the wild could only be justified through the development of a long-range objective to eventually return the species to areas of its historic range.

The early Red Wolf Recovery Program was multifaceted. Since approximately 98 percent of the final range of the species was in private ownership, the first priority of the program was to respond immediately to any and all canid damage complaints. This action gave the program access to canid populations on private lands, reduced human persecution of the species, and gained landowner cooperation. While responding to damage complaints, the program had to simultaneously develop methods for determining "pure" wolves and wolf-like hybrids, establish a captive-breeding/certification program, monitor and evaluate alleged red wolves already in the Nation's zoos, develop and disperse public information, and evaluate sites and procedures for reestablishment of the species in the wild.

After proposals from several zoo facilities were solicited, a captive-breeding/certification program was established on November 26, 1973, through a cooperative agreement between the Service and the Metropolitan Park Board of Tacoma, Washington. The program was to be administered by the Board's Point Defiance Zoological Park. Coordination of the effort was administered by the Fish and Wildlife Service's Beaumont, Texas, Field Office.

Pending development of procedures for appointing endangered species recovery teams under the new Endangered Species Act of 1973, the Southwest Regional Office of the Service established an Interim Red Wolf Recovery Team on August 4, 1974. Since a biological staff already was working with the species, the purpose of the team was to advise and administratively assist the program in accomplishing its objectives. Team members were selected, not so much for their biological knowledge, but for their knowledge of State and Federal agency processes, procedures, and resources. Russel W. Clapper, manager of the Service's Anahuac National Wildlife Refuge, was selected as the team leader. Serving with Clapper were George R. Abraham (Service), Joe Herring (Louisiana Department of Wildlife and Fisheries), and Floyd Potter (Texas Parks and Wildlife Department). A number of consultants were officially designated to advise the recovery team, and arrangements were made for the team to confer with anyone who might have special knowledge that would be helpful in developing recommendations. The Interim Red Wolf Recovery Team held its first working meeting in October 1974. Subsequently, the interim team was officially appointed in January 1975.

Due to the urgency of implementing recovery actions for the species, contracted studies were limited to those that would contribute directly to the objective of recovery. Proposed research projects were carefully evaluated for their potential for providing immediate information that would significantly aid the program in meeting its objectives. Only four projects were approved as having immediate benefit to the species. These projects related to sonographic analysis of canine vocalizations as an aid in locating and censusing canids in the wild (McCarley and Carley 1978), electrophoretic and chromosomal analysis of canids to aid in identification of red wolves and wolf-like hybrids, development of techniques for x-raying skulls of live canids to compare them with skulls of known wolves from museum collections, and an evaluation of internal and external parasites found in canine populations within the red wolf range.

Simultaneously, the demise of the species through hybridization with the coyote was being documented. Due to the confusion of characteristics displayed by the hybrid-infested population, no one character could be used to identify true wolves. Therefore, a number of indicators were used to determine whether an animal was a wolf. Those indicators included skull x-rays, knowledge of other canids examined from the same area, and the following minimum morphological standards:

	Male	Female
Skull length	8.6 in. (215 mm)	8.4 in. (210 mm)
Zygomatic breadth	4.4 in. (110 mm)	4.4 in. (110 mm)
Weight	50 lb. (22.5 kg)	42 lb. (19 kg)
Total length	53 in. (1,346 mm)	51 in. (1,295 mm)
Hind foot length	9.0 in. (229 mm)	8.75 in. (222 mm)
Ear length	4.75 in. (120.6 mm)	4.50 in. (114.3 mm)
Shoulder height	27 in. (685.8 mm)	26.5 in. (673.1 mm)
Brain/Skull ratio	23	23.5

Canids determined to be possible wolves were placed in the breeding/certification program or, if all facilities were full, released with radio collars on public lands or where private landowners gave permission. Since releasing captured coyotes and/or hybrids would tend to alienate private landowners and would increase the work load of the recovery effort due to unavoidable recaptures of animals, all canids determined to not be wolves were euthanized and their skeletal remains and data cards preserved as documentation of the canine population that was examined through the program. When the field program was concluded, all acquired specimens and data were transferred to the U.S. National Museum, Washington, D.C., for preservation and future reference.

From the fall of 1973 to July 1980, over 400 wild canids were examined through the recovery program. Of that number, only 43 wild canids were admitted to the breeding/certification program as probable red wolves (Carley 1975; McCarley and Carley 1978; Carley, personal communication). Due to the complexities of hybridization, final proof of the genetic integrity of the animals was determined only through the captive-breeding process itself. Offspring born to the program were maintained for 1 year and examined quarterly for the purpose of confirming the initial identification of their parents. As a result, a number of early litters were determined to consist of hybrids, and they and one or both of their parents were removed from the program. In some cases the parents of hybrid litters had to be bred with other wolves to produce a second litter that would determine which of the parents of the original litter was the hybrid. Although more of the original 43 wild canids in the program may have been true red wolves, short life spans, limited breeding facilities, and unavoidable medical problems (such as an outbreak of parvovirus) resulted in only 15 of the animals' becoming the founding stock of the red wolves existing today. The remains of all canids in the breeding/certification program, including those produced in captivity, continue to be preserved at the University of Puget Sound, Tacoma, Washington.

In the fall of 1984 the red wolf captive-breeding program was accepted by the AAZPA for development of an SSP. This ensured the integrity of red wolf captive-breeding efforts and greatly enhanced the Service's responsibility to properly undertake a selective breeding program for the species. The main thrust of this effort is to ensure the genetic integrity of the red wolf under captive conditions.

The red wolf breeding program evolved into one of the most successful captive-restoration efforts in the United States. Under the direction of Roland Smith, the Point Defiance Zoo and Aquarium continues to provide leadership in a national effort to maximize red wolf captive-breeding and cryopreservation banking techniques.

In 1978, Russel W. Clapper resigned as team leader of the Red Wolf Recovery Team. The administrative responsibility for the recovery team was then transferred from the Southwest Regional Office to the Southeast Regional Office in Atlanta, Georgia, and David W. Peterson (Service) was appointed new team leader. Abraham and Herring remained on the recovery team; however, with the center of recovery actions moving to the Southeast, the Texas Parks and Wildlife Department withdrew from formal participation on the team. Mary Anne Young was appointed as a new team member representing the concerns of environmental organizations.

Reintroduction Efforts

With the species at least safeguarded in captivity, program emphasis shifted to a strategy of reintroduction. Due to a history of failure in previous attempts to reintroduce gray wolves in various areas (Allen 1979, Weise et al. 1975, and Henshaw et al. 1979), initial thoughts centered on locating an area where an experimental reintroduction could be employed to test management and public information techniques. Bulls Island, a 5,000-acre (2,000-ha) component of the Cape Romain National Wildlife Refuge in South Carolina, was selected for such an experiment. A great deal of effort was expended in coordinating the project with local and State officials and securing necessary grass-roots support. A 50- x 50-foot (15- x 15-m) chain-link acclimation pen was constructed on the island, and on November 3, 1976, a pair of originally wild-caught adult red wolves was flown from Tacoma, Washington, to Charleston, South Carolina, carried by truck and boat to the refuge island, and placed in the pen. On December 13, 1976, they were released. The two animals wandered extensively, leaving Bulls Island and going to nearby Dewees and Capers Islands. After 9 days of freedom, the female left Capers Island and was recaptured on the mainland. The male was recaptured within hours on Bulls Island.

A second reintroduction experiment on Bulls Island began with the arrival of another pair of wild-caught adults in Charleston on July 5, 1977. This pair was kept in the acclimation pen for 6 months and fed island prey species, then released on January 5, 1978. The pair remained on Bulls Island and adjacent Capers Island for over 8 months. The decision to recapture them was consistent with the original objective of the experiment. It was concluded that both releases were successes and yielded valuable information for future reintroduction attempts.

For the next 2 years, the Red Wolf Recovery Team evaluated various sites for a possible mainland reintroduction project. Sites considered during that time included Everglades National Park and Big Cypress Swamp, Florida, and Ossabaw Island, Georgia. At a Red Wolf Recovery Team meeting in June 1978 at Savannah, Georgia, a Tennessee Valley Authority (TVA) representative invited the team to examine their Land Between The Lakes (LBL) area in west Kentucky and Tennessee for the purpose of evaluating it as a reintroduction site.

A field review of the LBL site was made by the team in July 1979, and a formal recommendation to initiate a red wolf reintroduction effort there was made to the Regional Director of the Service by the team leader. A series of meetings to brief the Kentucky and Tennessee State wildlife management agencies were held, and the Director of the Service, by letter of August 1, 1980, to TVA's Chairman of the Board of Directors, requested that TVA formally consider a red wolf reintroduction proposal at LBL.

In early 1980, Warren T. Parker, a wildlife biologist with the Service, was assigned the responsibility of overviewing the LBL reintroduction effort and locating other potential reintroduction sites. Over the next 3 years, a great deal of coordination and interagency work was accomplished. In July 1982, a Red Wolf Recovery

Plan was approved by the Service. Also, a formal proposal to reintroduce red wolves at LBL was published in October 1983 (Carley and Mechler 1983).

On September 25, 1983, the TVA Board approved the project, and on October 21, 1983, a formal news briefing was held at LBL. During the next 3 weeks, a great deal of media attention focused on the proposed wolf project at LBL. During the last week of November and the first 2 weeks of December 1983, three public meetings to review and discuss the proposal were held in Kentucky (Kentucky Lake State Park, Bowling Green, and Lexington), and four similar meetings were held in Tennessee (Paris, Dover, Clarksville, and Nashville).

Public sentiment was generally mixed in both States, and organized opposition from environmental, livestock, and hunting interests evolved into a major factor that politically doomed the proposal. Another major contributing factor was the reaction of hunters who feared that the presence of red wolves on LBL would result in injunctions and court actions by protectionist groups to stop hunting in the area. This view was reinforced by letters from Defenders of Wildlife and the Humane Society of the United States that voiced objections to the LBL reintroduction, based primarily on concerns that reintroduced red wolves would not have complete protection under the Endangered Species Act.

Based on these and other relevant points of contention, the Tennessee Wildlife Resources Agency unanimously rejected the LBL red wolf proposal at a public meeting on January 6, 1984. Shortly thereafter, the Kentucky Department of Fish and Wildlife Resources adopted a similar statement of opposition. The Service therefore withdrew the proposal.

In retrospect, the LBL proposal was technically carefully conceived. It now appears, however, that not enough time was allocated to working with local officials and the public. More time should have been directed to those interests that later surfaced in organized opposition to the reintroduction of <u>any</u> predator. The spread of the coyote into the LBL area during the early 1980s also complicated the process and raised serious biological questions about potential interbreeding. Also, administrative and decision-making processes involved in dealing with four cooperating agencies (TVA, the Service, and the wildlife agencies of Kentucky and Tennessee) made quick resolution of any problem more difficult. A great deal was learned from the LBL project, and these hard-taught lessons were soon to be applied in eastern North Carolina.

<u>Reintroduction at Alligator River National Wildlife Refuge, North Carolina</u>

In March 1984, the Prudential Insurance Company donated to the Service nearly 120,000 acres (48,000 ha) of freshwater nonriverine swamp, pocosin, and brackish marsh habitat in Dare and Tyrrell

Counties, North Carolina. These lands were later to become the Alligator River National Wildlife Refuge (Plate 2). Field studies conducted by the North Carolina Biological Survey (NCBS) (Potter 1982), and later work jointly done by NCBS and Service personnel, indicated that the refuge harbored a moderate to good small mammal population. In addition, intensive surveys indicated an absence of coyotes and feral dogs. There was no livestock in the county, and the mainland portion of the county was sparsely populated.

A decision was therefore made to attempt to reestablish red wolves on the new refuge, after which a great deal of time was devoted to developing a favorable public climate for such a project. A major effort to more fully involve national environmental organizations included a briefing in Washington, D.C. A detailed reintroduction proposal was developed (Parker 1987a), and the North Carolina Congressional delegation was thoroughly briefed, as was the North Carolina Wildlife Resources Commission, the Commissioner of Agriculture, and the Governor's staff. In concert with these contacts, the Dare County Commissioners were briefed. Numerous personal contacts were made with local citizens, especially prominent hunters and trappers. The new refuge manager, John Taylor, provided great assistance in working with the citizens of Dare County.

Dare County residents are deeply rooted in outdoor pursuits, many earning part or all of their income from commercial fishing and shellfishing. Recreational hunting, fishing, and trapping are the norm for many residents. As might be expected, some viewed with great suspicion the Federal Government's acquiring essentially the major portion of their county and introducing a large predator on it. But a series of four public meetings in February 1986 clearly demonstrated that as long as traditional usages of the new refuge were not significantly altered, the local public would support a red wolf reintroduction effort. Based on this information, the Regional Director of the Southeast Region of the Service, in consultation with the Director of the North Carolina Wildlife Resources Commission, determined that the project was feasible. Field survey work was completed, pens were constructed, and a special regulation designating red wolves reintroduced at Alligator River National Wildlife Refuge as experimental and nonessential was promulgated and published in the Federal Register on November 19, 1986 (Parker et al. 1986). In culmination of these efforts, four pairs of adult red wolves were shipped from Tacoma, Washington, to the refuge on November 12, 1986.

In 1987, a new Red Wolf Recovery Team was appointed, consisting of Roland Smith, assistant director of the Point Defiance Zoo, Tacoma, Washington; Bill Malloy, administrative director of the Wild Canid Survival and Research Center, Eureka, Missouri; Michael Pelton, University of Tennessee, Knoxville, Tennessee; Don Wood, Florida Game and Fresh Water Fish Commission, Tallahassee, Florida; Curtis Carley, Service, Albuquerque, New Mexico; and Warren Parker, team leader,

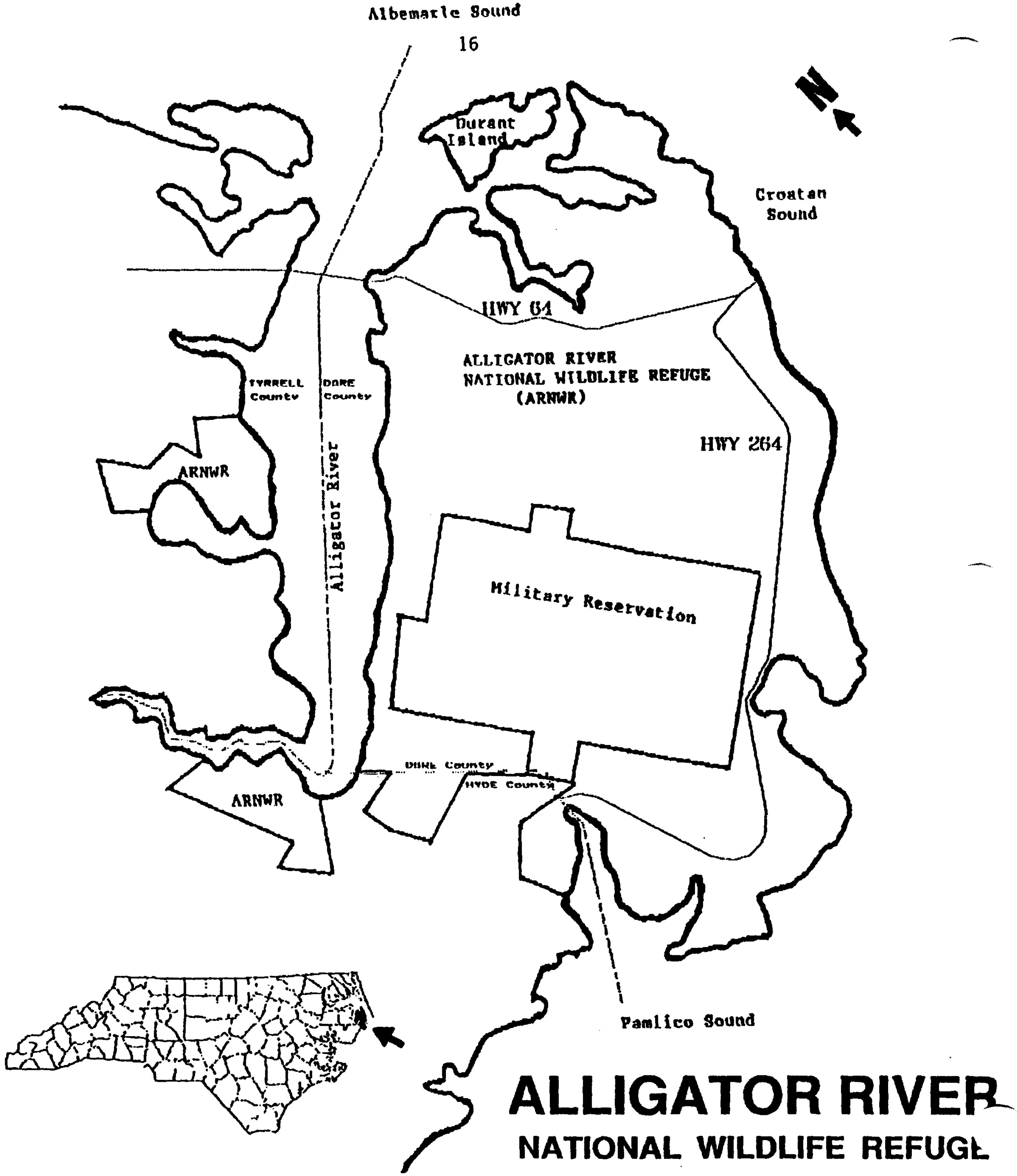

Albemarle Sound
N
Durant Island
Croatan Sound
HWY 64
ALLIGATOR RIVER
NATIONAL WILDLIFE REFUGE
(ARNWR)
TYRRELL County
DARE County
HWY 264
ARNWR
Alligator River
Military Reservation
DARE County
HYDE County
ARNWR
Pamlico Sound
ALLIGATOR RIVER
NATIONAL WILDLIFE REFUGE

PLATE 2

Service, Asheville, North Carolina. L. David Mech, Service, St. Paul, Minnesota, was designated as team technical advisor, and Mary Anne Young, Service, Atlanta, Georgia, was designated as Regional Office team advisor. Malloy and Carley resigned soon after their appointment; Victor Nettles, School of Veterinary Medicine, University of Georgia, replaced Malloy; and U. S. Seal, Veterans Administration Hospital, St. Paul, Minnesota, replaced Carley. The first team meeting was held at the refuge on December 2 and 3, 1987.

A primary facet in developing the Alligator River Refuge project was the use of a special tracking collar that had the capability of injecting an immobilizing drug upon radio command (Mech et al. 1984). The delivery of these collars was expected in May 1987. Because of unexpected delays in development of the 3-M Corporation capture collar, wolves were not released until September 1987, a major deviation from the proposed spring 1987 release. Since then seven more releases involving 12 different wolves have been conducted. Most animals have adjusted well to life in the wild. This adjustment was clearly demonstrated by the production of two litters in the wild during April 1988 and two litters in 1990. As of July 1990, there were nine free-ranging adult wolves in the refuge and an as yet undetermined number of pups born during the spring. In summary, the first 3 years of work in northeastern North Carolina indicate that it will be possible to restore a red wolf population to the Alligator River National Wildlife Refuge.

Island Propagation Strategy

A strategy to propagate wild red wolf offspring was initiated on November 19, 1987, when a pair of adult wolves was shipped from the captive-breeding project in Washington to Cape Romain National Wildlife Refuge, South Carolina. These animals were placed in an acclimation pen on Bulls Island and were allowed to breed. On April 22, 1988, four pups were born, two of which survived. On July 8 these young animals and their parents were released from the pen. Although the female parent was killed by an alligator (Alligator mississippiensis), the male and two pups adjusted well to life in the wild; in December 1988 the family unit was recaptured, and the two pups were taken to Alligator River Refuge and released. These pups adjusted to their new environment and offer great promise for the concept of island propagation. A replacement female red wolf was brought to Bulls Island in January 1989, and the adults were bred in the acclimation pen. Five pups were whelped, and the family unit was released on August 8, 1989. The replacement female was soon killed by an alligator, as was a pup. Hurricane Hugo hit the Bulls Island area in September 1989 and devastated the island's pristine overstory of live oaks and loblolly pine. The adult male and four pups survived the storm, but the male was later found dead, his death probably resulting from injuries sustained during the storm. Bulls Island continues to play an important role in red wolf recovery efforts. As of July 1990 a pair of juvenile animals are free on the island.

On January 10, 1989, a pair of captive adult red wolves was taken to Horn Island, Mississippi, for propagation purposes. This 3,500-acre (1,400-ha) island is a component of the National Park Service's Gulf Islands National Seashore. These adults bred in their acclimation pen and had seven pups. They were released from the pen on August 1, 1989, and adjusted extremely well to life in the wild. A third island project was recently initiated on St. Vincent National Wildlife Refuge in Florida. Two adults and their two pups were recently released onto this 12,000-acre (4800-ha) island refuge. The objective of these island projects is to gradually infuse wild red wolves into a project that, at the present time, has to depend on captive stock (Parker 1987b).

Recovery Potential

Probably the biggest factor weighing against the red wolf recovery effort is the notion that the species cannot survive in any association with coyotes. This conclusion is based on poorly understood factors that surrounded the hybrid swarm that threatened what was left of red wolf range in the 1970s (Nowak 1979). However, when red wolf numbers in Louisiana and Texas reached extreme lows, it became difficult, and in some cases impossible, for a lone red wolf to locate a mate. Under these unusual circumstances, interbreeding with coyotes took place, and, indeed, the red wolf as a species came dangerously close to losing its identity. Speciation, however, is a powerful force in nature. Red wolves and coyotes existed for thousands of years in central Texas and Oklahoma in narrow zones of sympatry. Man's intervention ultimately created a set of circumstances that simultaneously devastated red wolf habitat and populations. This alteration of a naturally occurring system permitted the more adaptable coyote to fill vacant, altered habitats. When man's attention finally turned to the plight of the red wolf, there was only a relict population to examine. We can now surmise that this population had been tempered by a host of biological, as well as environmental, factors.

In examining canid literature, it becomes obvious that there is a hierarchy among the various species. Sargeant et al. (1987) demonstrated spatial relationships between coyotes and red foxes in North Dakota, wherein a red fox population gradually declined as a coyote population increased. Other investigators have drawn the same conclusions regarding coyote/gray wolf range overlaps (Carbyn 1982, Mech 1970). Berg and Chesness (1978) and Fuller and Keith (1981) concluded that coyotes avoid wolf territories.

Since there are few large areas left within the historic range of the red wolf that are suitable for reintroduction purposes, it is important that these areas be critically examined as soon as practical. This is frustrated, however, by the fact that at least 80 percent of this historic range is now occupied by coyotes. Therefore, it is imperative that carefully designed projects be developed and executed that would measure impacts of any red wolves introduced into areas with resident populations of coyotes. As of the date of this plan, a study is underway in the Great Smoky Mountains National Park in western North Carolina and eastern Tennessee to address this issue. If red wolves, like gray wolves, can compete with coyotes on good range, and thus develop a sympatric or allopatric relationship with resident coyotes, then long-term management objectives for the species would become more attainable.

In the interim, special red wolf propagation projects on small controlled island components of the national wildlife refuge system and national park system lands are of special interest. Young wild wolves born on these islands will be utilized in possible reintroduction efforts and in various captive-breeding projects. Yet even with these small island projects and three or more major mainland projects, the genetic vigor of the species needs to be heavily augmented with various captive-breeding projects. This reality is best expressed in numbers of red wolves that can be placed and managed in the wild. This figure would likely never exceed 200 to 250 animals. To maintain genetic variation and retard genetic drift within the species, it is likely that 300 to 350 red wolves will have to be continually maintained in captivity.

An important adjunct to reintroductions into the wild and captive breeding is the cryopreservation of red wolf semen and embryos. Significant advances have been made in recent years in the field of genetic banking, and these advances offer great promise in the maintenance of endangered species (Dresser 1988, Wildt et al. 1987).

Where mainland reintroduction attempts or island propagation strategies are found to be feasible, careful coordination with State agricultural and wildlife agencies is a must. The degree of direct State cooperation will depend on many factors, including political and budgetary constraints. In addition, the concerns of local property owners and residents must be addressed prior to approval of any wolf reintroduction project. NEPA documentation and special "experimental" regulations must also address public concerns. Without local citizen support, it is doubtful that successful wolf reintroductions can be accomplished.

The concerns of organized special interest groups, such as State and local Farm Bureau offices, local and national environmental organizations, hunting interests, livestock associations, etc., must also be recognized. The 1982 Amendments to the Endangered Species Act regarding experimental and nonessential designation of otherwise endangered animals, provides the Service with a powerful tool to allay public and institutional fears and concerns yet still provide protection for reintroduced animals.

Effective reintroduction strategies must always consider potentials for wolf/livestock interactions. While the special regulation referenced above will provide the legal mechanism for possible take of depredating red wolves, private livestock owners must also have some means available for monetary compensation for animals killed by wolves. Techniques are available for designating predator kills or injuries (wolves, coyotes, bobcats), and cooperating private organizations can be enlisted to provide the financial resources needed for these projects. Red wolf reintroduction efforts should realistically avoid areas where a substantial livestock industry exists. Red wolves historically preyed on livestock, but practically all of these early incidents involved free-ranging stock. It is thought that present-day animal husbandry techniques of fencing and herd management will virtually preclude depredation problems. If such problems develop, the Service would act in concert with appropriate Federal and State agencies, especially Department of Agriculture, Animal Damage Control experts, to capture offending animals.

In conclusion, the Red Wolf Recovery Team is of the opinion that red wolf reintroductions are feasible in many areas of the Southeastern United States if carefully developed protocols and strategies are pursued within a framework of logic and realism.

PART II

A STRATEGY FOR CONSERVATION BASED ON VIABLE POPULATIONS

Introduction

Conservation strategies for endangered species must be based on viable populations. While it is necessary, it is not sufficient merely to protect endangered species *in situ.* They must also be managed.

Populations of many species maintained under the pressures of habitat degradation and unsustainable exploitation will be small; i.e., a few tens to a few hundreds (in some cases, even a few thousands) depending on the species. As such, these populations are endangered by a number of environmental, demographic, and genetic problems that are stochastic in nature and that can cause extinction.

Environmentally, small populations can be devastated by catastrophic events (disasters and epidemics), as exemplified by the case of the black-footed ferret, or devastated by even less drastic fluctuations in the environment. Demographically, small populations can be disrupted by random fluctuations in survivorship and fertility. Genetically, small populations lose diversity needed for fitness and adaptability.

Minimum Viable Populations (MVPs)

The smaller the population is and the longer the period of time it remains so, the greater these risks will be and the more likely extinction is to occur. As a consequence, conservation strategies for species which are reduced in number, and which most probably will remain that way for a long time, must be based on maintaining certain minimum viable populations; i.e., populations large enough to permit long-term persistence despite genetic, demographic, and environmental problems.

There is no single magic number that constitutes an MVP for all species or for any one species all the time. Rather, an MVP depends on both the genetic and demographic objectives for the program and the biological characteristics of the taxon or population of concern. A further complication is that current genetic, demographic, and environmental factors must be considered separately in determining MVPs, although there certainly are interactions between the genetic and demographic factors. Moreover, the scientific models for assessing risks in relation to population size are still in the early stages of development. Nevertheless, by considering both the genetic and demographic objectives of the program and the biological characteristics pertaining to the population, scientific analyses can result in ranges of population sizes that will provide calculated protection against stochastic problems.

Genetic and Demographic Objectives of Importance for MVP

1. The probability of survival (e.g., 50 percent or 95 percent) desired for the population;

2. The kind of genetic variation to be preserved (e.g., allelic diversity or average heterozygosity);

3. The percentage of the genetic diversity to be preserved (e.g., 90 percent, 95 percent, etc.); and

4. The period of time over which demographic security and genetic diversity are to be sustained (e.g., 50 years, 200 years).

In terms of demographic and environmental problems, for example, the objective may be 95 percent probability of survival for 200 years. Models are emerging to predict persistence times for populations of various sizes under threat. In terms of genetic problems, the objective may be to preserve 95 percent of average heterozygosity for 200 years. Again, models are available. However, it is essential to realize that such terms as viability, recovery, self-sustainment, and persistence can be defined only when quantitative genetic and demographic objectives have been established, including the period of time for which the program (and population) is expected to continue.

Biological Characteristics of Importance for MVP

Generation time: As populations decline in number, genetic diversity is lost generation by generation, not year by year. Hence, species with longer generation times will have fewer opportunities to lose genetic diversity within the given period of time selected for the program. As a consequence, to achieve the same genetic objectives, MVPs can be smaller for species with longer generation times. Generation time is qualitatively the average age at which animals produce their first offspring. Quantitatively, it is a function of the age-specific survivorships and fertilities of the population which will vary naturally and which can be modified by management; e.g., to extend generation time.

The number of founders. A founder is a constituent animal of a source population that establishes a derivative population. Technically, to constitute a full founder, an animal should also be unrelated to any other representative of the source population and non-inbred.

The more founders, the better. The more representative the sample of the source gene pool is, the smaller the MVP that is required for genetic stability. There is also a demographic founder effect--the larger the number of founders, the less likely extinction is due to demographic stochasticity. However, for larger vertebrates there is a point of diminishing return (Figure 1), at least in genetic terms. Hence a common objective is to obtain at least 20 to 30 effective

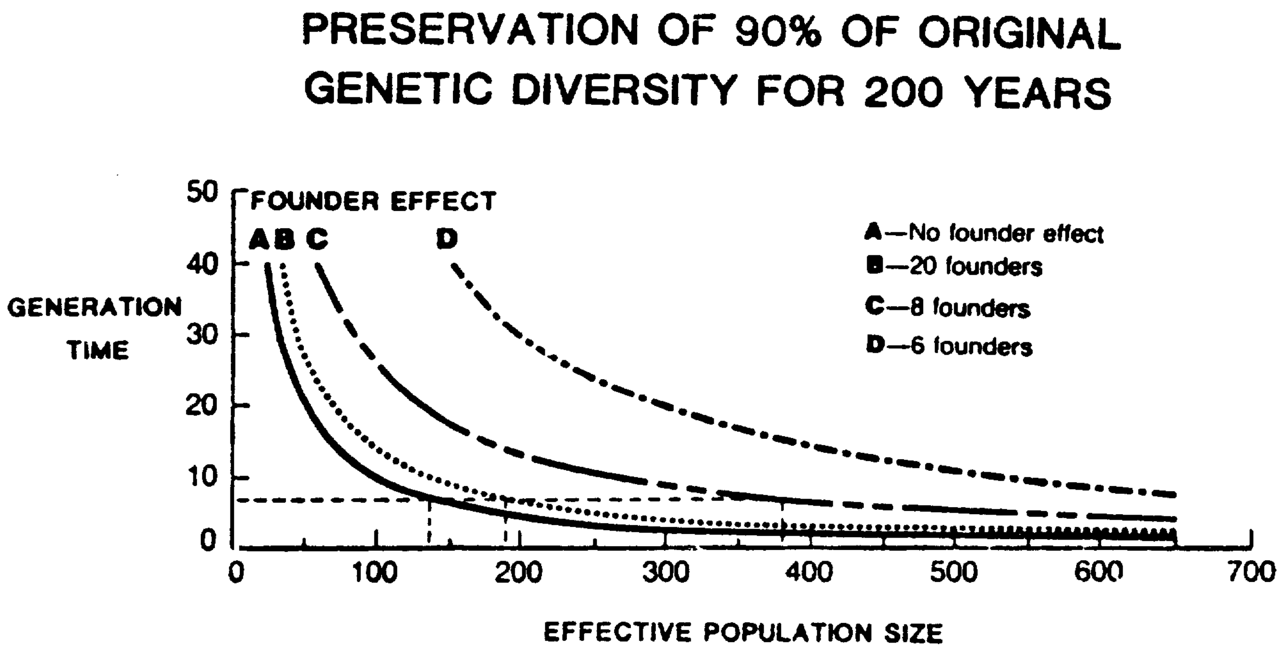


Figure 1

founders to establish a population. If this objective can't be achieved, one must do the best with what is available.

Effective Population Size. Another very important consideration is the effective size of the population, designated N_e. N_e is a measure of the way the members of the population are reproducing to transmit genes to the next generation. N_e is usually much less than N. For example, in the grizzly bear, N_e/N ratios of about .25 have been estimated (Harris and Allendorf 1989). As a consequence, if the genetic models prescribe an N_e of 500 to achieve some set of genetic objectives, the MVP might have to be 2,000.

Growth Rate. The higher the growth rate, the faster a population can recover from small size, thereby "outgrowing" much of the demographic risk and limiting the amount of genetic diversity lost during the so-called "bottleneck." It is important to distinguish MVPs from bottleneck sizes.

Population Viability Analysis (PVA)

The process of deriving MVPs by considering various factors;. i.e., sets of objectives and characteristics, is known as Population Viability (sometimes Vulnerability) Analysis. Deriving applicable results in PVA requires interactive efforts of population biology specialists with managers and researchers. PVA has already been applied to some degree to about 30 species.

Considering genetics, PVA in general indicates it will be necessary to maintain populations in hundreds or thousands to preserve a high percentage of the gene pool for several centuries.

MVPs, to contend with demographic and environmental stochasticity, may need be even higher than predicted to preserve genetic diversity, especially if a high probability of survival for an appreciable period of time is desired. For example, a 95 percent probability of survival may entail actually maintaining a much larger population whose persistence time is 20 times greater than required for 50 percent (i.e., average) probability of survival; 90 percent, 10 times greater. From another perspective, it can be expected that 50 percent of an actual population will become extirpated before 70 percent of the average persistence time elapses.

Larger vertebrates almost certainly need population sizes of several hundred or perhaps thousands to be viable. In view of the stochastic problems, more is always better.

Metapopulations and Minimum Areas

MVPs, of course, imply minimum critical areas of natural habitat that will be relatively vast for large carnivores like the red wolf. Consequently, it will be impossible to maintain single, contiguous populations of the hundreds or thousands required for viability.

However, it is possible for a number of smaller populations to be viable if they are managed as a single larger population (a so-called metapopulation) whose collective size is equivalent to the MVP. Actually, distributing animals over multiple "subpopulations" will increase the effective size of the total number maintained in terms of the capacity to withstand stochastic problems. Any one subpopulation may become extinct, or nearly so, due to these causes. But through recolonization or reinforcement from other subpopulations, the metapopulation will survive. Metapopulations occur in nature with much local extinction and recolonization of constituent subpopulations occurring.

Unfortunately, as wild populations become fragmented, natural migration for recolonization may become impossible. Hence, metapopulation management will entail interchanging animals to preclude or mitigate genetic and demographic problems. Migrants must reproduce in the new area, so in cases of managed migration, it will be important to monitor the genetic and demographic performance of the migrants.

MVPs strictly imply benign neglect. It is possible to reduce the MVP required for some set of objectives or, considered from an alternative perspective, extend the persistence time for a given size population through management intervention to correct genetic and demographic problems as they are detected. In essence, many of these measures will increase N_e.

Management intervention for the red wolf after the first wild populations are established will include actions to improve juvenile survival (e.g., translocation of otherwise doomed dispersing young animals to available habitat to which they could not migrate naturally), introducing more breeding-age females to an area depauperate in this sex because of random biases toward males in a local area, accelerating turnover in dominant males that might be monopolizing breeding of multiple females and thereby causing distortion of sex ratios and family sizes with consequent depression of N_e, relocation of animals to prevent reproduction by close relatives, etc.

Such interventions are manifestations of the fact that as natural sanctuaries and their resident populations become smaller, they are in effect transformed into megazoos that require much the same kind of intensive genetic and demographic management as species in captivity.

Captive Propagation

Another way to enhance viability is to reinforce wild populations with captive propagation. The advantages of captive propagation include protection from unsustainable exploitation (e.g., poaching), moderation of environmental vicissitudes for at least part of the population, more genetic management and hence enhanced preservation of the gene pool, accelerated expansion of the population to move toward the desired MVP and to provide animals more rapidly for introduction into new areas, and increased total numbers of animals maintained.

It must be emphasized that the purpose of captive propagation is to reinforce, not replace, wild populations. Zoos must serve as reservoirs of genetic and demographic material that can periodically be infused into natural habitats to reestablish species that have been extirpated or to revitalize populations that have been debilitated by genetic and demographic factors.

The survival of a growing number of endangered species will depend in large part on assistance from captive propagation. Indeed, what appears optimal and inevitable are conservation strategies incorporating both captive and wild populations interactively managed for mutual support and survival. The captive population can serve as a vital reservoir of genetic and demographic material, whereas the wild population, if large enough, can continue to subject the species to natural selection. This general strategy has been adopted by the International Union for the Conservation of Nature and Natural

Resources (IUCN) which now recommends that captive propagation be invoked any time a taxon's wild population declines below 1,000 (IUCN 1988).

Zoos in many regions of the world are organizing scientifically-managed and highly-coordinated programs for captive propagation to reinforce natural populations. In North America, these efforts are being developed under the auspices of the AAZPA, the Captive Breeding Specialist Group (CBSG) of the IUCN, and are known as SSPs.

Captive propagation for species conservation purposes requires obtaining as many founders as possible; rapidly expanding the population (normally to several hundred animals); and managing the population closely, both genetically and demographically. Captive programs can also involve research to facilitate management in the wild as well as in captivity and for interactions between the two.

An example of a conservation/recovery strategy incorporating both captive and wild populations is the black-footed ferret. The species now evidently survives only in captivity. Because the decision to establish a captive population was delayed, the situation became so critical that moving all the animals into captivity seemed the only option, circumstances that also apply to the California condor. Another option may have been available if action to establish a captive population had occurred earlier. Consideration of the survivorship pattern, which exhibited high juvenile mortality for ferrets, suggested that young animals destined to die in the wild might be removed with little or no impact.

In general, AAZPA and CBSG have become involved in these kinds of strategies and programs worldwide. It should be emphasized that the kind of conservation strategy that has been delineated would apply regardless of how taxonomic problems of defining what constitutes separate entities to be preserved (i.e., evolutionary significant units [ESUs]) are resolved. The goal has to be to develop viable populations of each of the ESUs or phylogeographic units.

Summary

A conservation strategy or recovery plan based on viable populations for a taxon like the red wolf should:

1. Expand the population in numbers and in range (multiple populations of 50 to 100 each), all managed as a metapopulation.

2. Maintain a vigorous program of captive propagation to reinforce the wild populations.

3. Intervene in wild populations to ameliorate genetic, demographic, and environmental problems.

4. Conduct an extensive and continuing population viability analysis as situations change, knowledge increases, and science advances.

PART III

RED WOLF SPECIES SURVIVAL PLAN

The North American red wolf population numbered 131 animals in 19 facilities on July 1, 1990, with a sex ratio of 57 males to 74 females. Not included are two litters of pups born in the wild at Alligator River National Wildlife Refuge. As of the date of this recovery/species survival plan, the number and sex of these two litters is unknown. Included are a pair of juvenile animals in the wild on Bulls Island, a component of the Cape Romain National Wildlife Refuge in South Carolina, five juveniles in the wild on Horn Island, part of the Gulf Islands National Seashore in Mississippi, and two adults and their two pups just released into the wild on St. Vincent National Wildlife Refuge, Florida.

There are presently 19 zoos and captive facilities in the United States cooperating with the red wolf breeding program. These include the Alexandria Zoo (Louisiana), Audubon Park Zoo (Louisiana), Baton Rouge Zoo (Louisiana), Beardsley Zoo (Connecticut), Birmingham Zoo (Alabama), Burnet Park Zoo (New York), Fossil Rim Wildlife Center (Texas), Fresno Zoo (California), Knoxville Zoo (Tennessee), Land Between The Lakes (TVA, Kentucky), Los Angeles Zoo (California), Lowry Park Zoo (Florida), The National Zoo (Washington, D.C.), Oglebay Park Zoo (West Virginia), Point Defiance Zoo and Aquarium (Washington), Ross Park Zoo (New York), Tallahassee Junior Museum (Florida), The Texas Zoo (Texas), and the Wild Canid Survival and Research Center (Missouri).

Based on the information available, it is possible to identify several demographic trends for the red wolf population (useful demographic concepts and terms are explained on page 29).

1. The sex ratio is biased, currently showing 14 percent more females than males (Table 1). This reflects a greater production of females in the last 5 years and, on average, lower age-specific mortality for females for census years 1984-1989 (Tables 2 and 3).

2. The age distribution shows a healthy breeding group of prime adults that could rapidly expand the captive population to carrying capacity, while meeting the demands for the reintroduction program (Table 1 and Figure 2).

3. Age-specific survival and fertility rates are provided by the life table (Tables 2 and 3, Figure 3). The age-specific fertility rate for males is zero for those in the 0-2 age classes, increases steadily through the 8-11 age classes, then drops off to zero in the 14-15 plus age classes. Female age-specific fertility is slightly different, being low but greater than zero in the 0-2 age classes, increasing steadily

DEMOGRAPHY GLOSSARY

Age — Age class in years.

Px — Age-specific survival.

Probability that an animal of a given age will survive to the next age class.

Lx — Age-specific survivorship.

Probability of a newborn surviving to a given age class.

Mx — Age-specific fertility.

Average number of offspring (of the same sex as the parent) produced by an animal in the given age class. Can also be interpreted as average percentage of animals that will reproduce.

r — Instantaneous rate of change.

If $r < 0$ ...... Population is declining

$r = 0$ ...... Population is stationary (Does not change in number)

$r > 0$ .... Population is increasing

lambda — Percent of population change per year.

If lambda < 1 ...... Population is declining

lambda = 1 ...... Population is stationary (Does not change in number)

lambda > 1 ...... Population is increasing

R_o — Net reproductive rate, the rate of change per generation.

If $R_o < 1$ ...... Population is declining

$R_o = 1$ ...... Population is stationary (Does not change in number)

$R_o > 1$ ...... Population is increasing

G — Generation Time

Average length of time between the birth of a parent and the birth of its offspring. Equivalently, the average age at which an animal produces its offspring)

RED WOLF
AGE STRUCTURE OF SSP POPULATION

9 JULY 1989

AGE CLASS IN YEARS	MALES	FEMALES
0 - 1	16	21
1 - 2	8	8
2 - 3	4	8
3 - 4	5	8
4 - 5	4	4
5 - 6	2	4
6 - 7	5	5
7 - 8	2	2
8 - 9	2	1
9 - 10	1	3
10 - 11	1	2
11 - 12	0	1
12 - 13	1	1
13 - 14	0	0
TOTALS	51	68

Table 1

RED WOLF
LIFE TABLE

(CAPTIVE POPULATION 01 APRIL 1966 - 01 JULY 1989)

MALES					FEMALES				
Age	Px	Lx	Mx		Age	Px	Lx	Mx	
0	0.492	1.000	0.000	r =	0	0.485	1.000	0.010	r =
1	0.702	0.492	0.000	0.0755	1	0.774	0.485	0.046	0.0793
2	0.928	0.345	0.074		2	1.000	0.375	0.443	
3	0.902	0.321	0.776	lambda =	3	0.843	0.375	0.520	lambda =
4	0.827	0.289	0.703	1.078	4	0.932	0.316	0.313	1.083
5	0.942	0.239	0.429		5	0.800	0.295	0.540	
6	0.860	0.225	0.929	Ro =	6	0.859	0.236	1.087	Ro =
7	0.730	0.194	0.978	1.729	7	0.782	0.203	0.933	1.596
8	0.859	0.141	0.611		8	0.778	0.158	1.175	
9	0.910	0.121	1.538	G =	9	0.823	0.123	1.622	G =
10	0.890	0.111	1.900	7.253	10	0.581	0.101	1.104	5.893
11	0.875	0.098	0.959		11	0.351	0.059	0.000	
12	0.505	0.086	0.331		12	1.000	0.021	0.000	
13	1.000	0.043	1.500		13	1.000	0.021	0.000	
14	0.500	0.043	1.203		14	1.000	0.021	0.000	
15	1.000	0.022	1.250		15	1.000	0.021	0.000	
16	1.000	0.022	0.000		16	1.000	0.021	0.000	
17	1.000	0.022	0.000		17	1.000	0.021	0.000	
18	1.000	0.022	0.000		18	1.000	0.021	0.000	
19	0.000	0.022	0.000		19	0.000	0.021	0.000	
20	0.000	0.000	0.000		20	0.000	0.000	0.000	

Table 2

RED WOLF LIFE TABLE

(CAPTIVE POPULATION 01 JULY 1984 - 01 JULY 1989)

MALES					FEMALES				
Age	Px	Lx	Mx		Age	Px	Lx	Mx	
0	0.603	1.000	0.000	r =	0	0.636	1.000	0.000	r =
1	0.803	0.603	0.000	0.1237	1	0.895	0.636	0.000	0.0921
2	1.000	0.484	0.075		2	1.000	0.569	0.239	
3	1.000	0.484	1.166	lambda =	3	0.856	0.569	0.550	lambda =
4	0.900	0.484	0.418	1.132	4	0.913	0.487	0.269	1.097
5	1.000	0.436	0.117		5	0.859	0.445	0.511	
6	0.768	0.436	1.407	Ro =	6	0.870	0.382	0.729	Ro =
7	0.674	0.335	0.806	2.140	7	0.755	0.332	0.625	1.644
8	0.772	0.226	0.000		8	0.878	0.251	1.105	
9	1.000	0.174	0.757	G =	9	1.000	0.220	0.331	G =
10	1.000	0.174	0.000	6.150	10	0.700	0.220	0.000	5.397
11	0.733	0.174	0.415		11	1.000	0.154	0.000	
12	0.533	0.128	0.000		12	1.000	0.154	0.000	
13	1.000	0.068	0.888		13	1.000	0.154	0.000	
14	0.667	0.068	1.203		14	1.000	0.154	0.000	
15	1.000	0.045	1.250		15	1.000	0.154	0.000	
16	0.500	0.045	0.000		16	1.000	0.154	0.000	
17	1.000	0.023	0.000		17	1.000	0.154	0.000	
18	1.000	0.023	0.000		18	1.000	0.154	0.000	
19	0.000	0.023	0.000		19	0.000	0.154	0.000	
20	0.000	0.000	0.000		20	0.000	0.000	0.000	

Table 3

RED WOLF
AGE STRUCTURE

01 JULY 1989

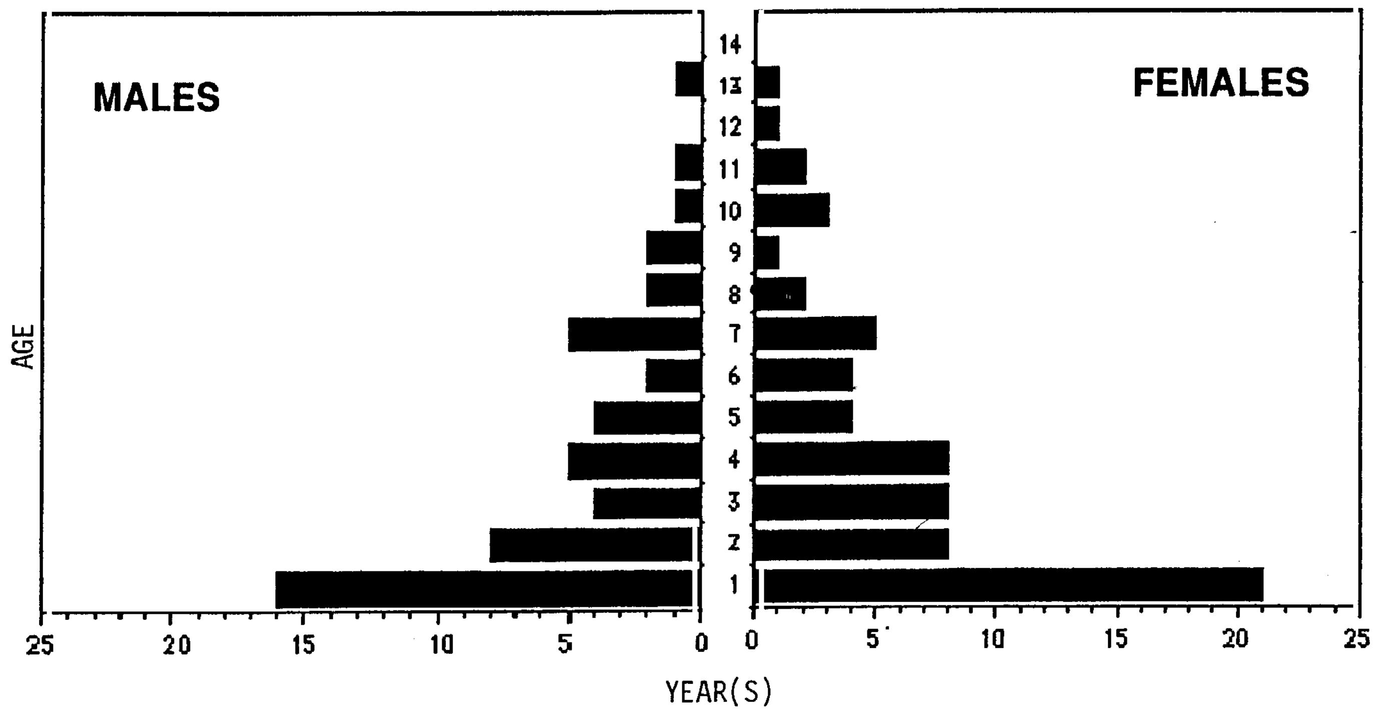
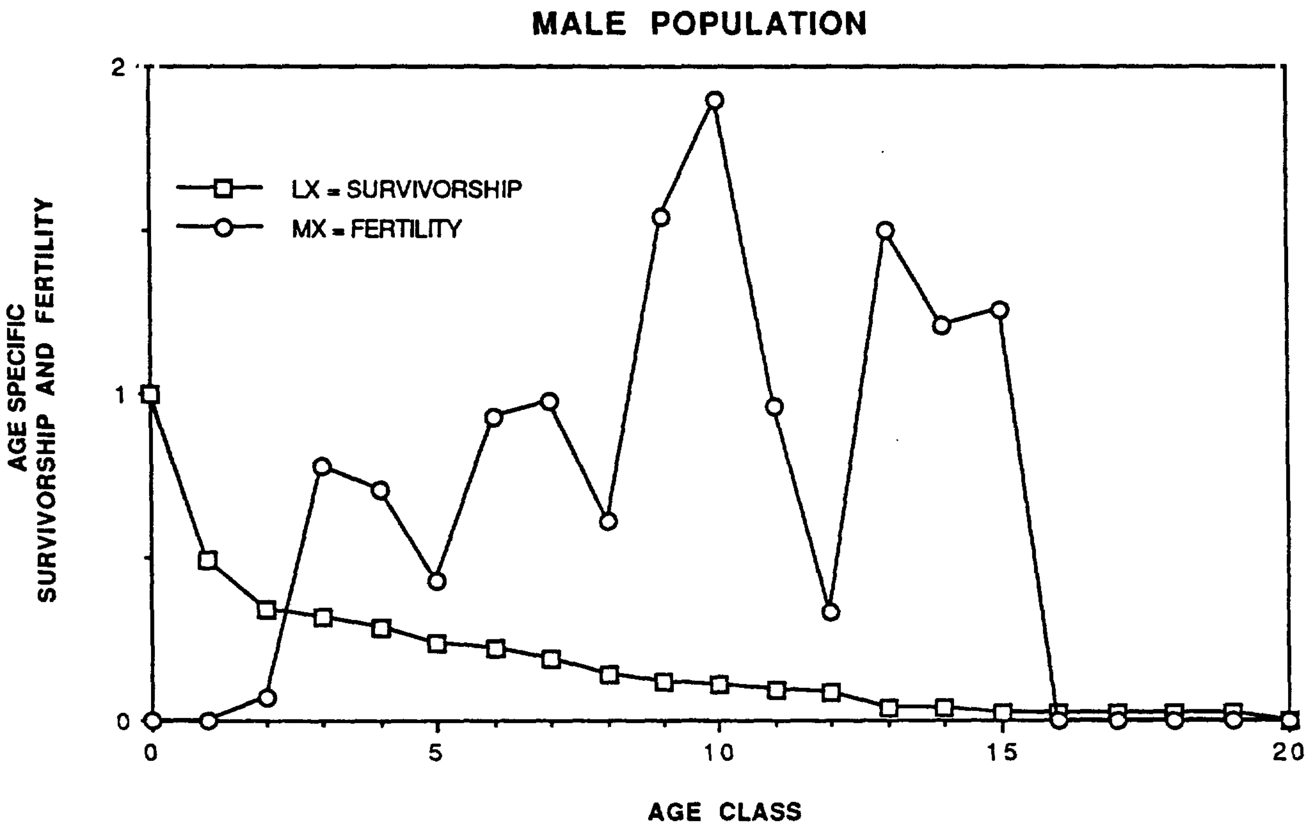


Figure 2


MALE POPULATION
LX = SURVIVORSHIP
MX = FERTILITY
AGE SPECIFIC
SURVIVORSHIP AND FERTILITY
AGE CLASS
0
1
2
0
5
10
15
20

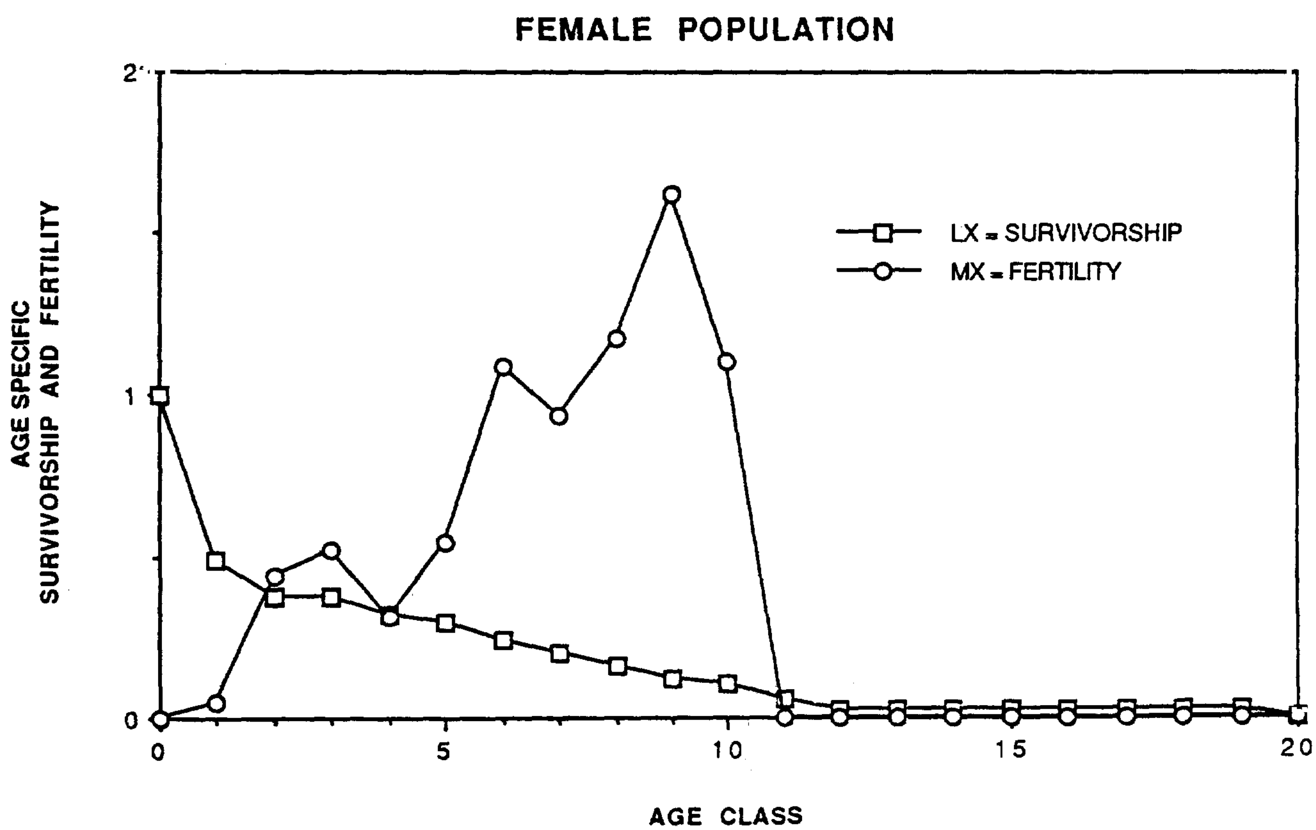

FEMALE POPULATION
LX = SURVIVORSHIP
MX = FERTILITY
AGE SPECIFIC
SURVIVORSHIP AND FERTILITY
AGE CLASS
0
1
2
0
5
10
15
20

Figure 3

through the 6-11 age classes, then dropping to zero. Actual ages at first reproduction by individual animals are provided by Table 4.

4. While over the history of the population the average growth rate has been about 8 percent per year (i.e., lambda = 1.08), it is expected that the potential for increase could be expanded to 20 percent per year (lambda = 1.2; see Tables 2 and 3). Nevertheless, for some of the later calculations and projections, an intermediate figure of 10 percent (lambda = 1.1) has been used.

5. Generation time is different for males and females and has declined slightly in recent years (Tables 2 and 3). The average of both males and females is about 6.5 years. If there is an attempt to increase the rate of growth, the generation time will decline further. For purposes of the carrying capacity calculations, a generation time of 6 years has been used.

Genetically, there have been 14 potential founders (i.e., animals from the wild that have been moved into captivity) in the population (Tables 5, 6, and 7; a full explanation of genetic concepts and terms is provided on page 41). Of those, all have produced offspring. However, the effective number of founders is lower, as indicated by the Founder Genome Equivalents and the Number of Founder Genomes Surviving, which provide somewhat different measures of how the genetic diversity represented by the potential founders has been lost over the history of the captive population (Table 7).

There are three ways that the effective number of founders can be reduced below the actual number of animals moved into captivity from the wild:

1. The first and most obvious way is that some of the animals taken from the wild don't reproduce.

2. The second way is that some of the genes or alleles from each founder may be lost when its lineage passes through a bottleneck--a generation in which there are only one or a few offspring--so that not all of the founder's alleles are transmitted into the next generation. The most extreme example is when a founder has only one F_1 offspring. Then only one-half of the founder's genes will survive in the pedigree from that point onward. The number of Founder Genomes Surviving indicates how much loss has occurred due to bottlenecks. This number represents the maximum number of full founders from the wild (i.e., with no loss of their genomes) that would be required to contain as much genetic diversity as still exists in the captive population. As indicated in Table 7, the number of Founder Genomes Surviving is about 10.4.

RED WOLF
ACTUAL AGE AT FIRST REPRODUCTION

(HISTORICAL POPULATION)

MALES		FEMALES	
STUDBOOK	AGE/MONTH	STUDBOOK	AGE/MONTH
291	22	132	11
327	22	152	12
164	33	54	24
53	34	79	24
140	34	195	24
146	34	196	24
213	34	216	24
227	34	244	24
247	34	279	24
280	34	40	25
293	34	303	35
268	37	112	36
242	45	269	36
137	46	301	36
26	47	302	36
33	47	65	38
39	47	245	48
42	47	277	48
144	47	36	49
52	58	194	60
18	59	23	61
28	59	29	61
24	60	32	61
219	70	30	62
8	71	205	72
17	71	233	72
179	71	12	73
211	72	35	73
184	82	215	73
6	83	14	74
34	83	142	84
212	83	15	85
11	107	16	85
3	108	7	86
2	120	13	86

Table 4

RED WOLF
SSP POPULATION
GENE DROP ANALYSIS

9 JULY, 1989

0 = WILD; -1 = UNK

	ID	Sex	Sire	Dam	Status
1	6	M	0	0	D
2	8	M	0	0	D
3	11	M	0	0	D
4	12	F	0	0	D
5	13	F	0	0	D
6	14	F	0	0	D
7	16	F	0	0	D
8	17	M	0	0	D
9	24	M	0	0	D
10	26	M	0	0	D
11	30	F	0	0	D
12	33	M	0	0	D
13	34	M	0	0	D
14	42	M	0	0	D
15	52	M	6	12	A
16	53	M	6	12	D
17	54	F	6	12	A
18	79	F	8	16	A
19	111	F	33	14	A
20	112	F	33	14	D
21	132	F	6	12	A
22	135	M	24	30	A
23	137	M	17	132	D
24	142	F	11	54	A
25	143	F	11	54	A
26	146	M	42	79	D
27	152	F	53	14	D
28	155	F	53	14	A
29	164	M	6	13	D
30	165	M	6	13	A
31	179	M	24	152	A
32	180	M	24	152	A
33	184	M	34	132	D
34	194	F	8	13	D
35	195	F	8	13	A
36	196	F	26	54	D
37	205	F	11	54	A
38	208	M	52	132	A
39	211	M	24	112	D
40	212	M	24	112	A
41	213	M	24	112	D
42	215	F	24	112	A
43	216	F	24	112	D
44	219	M	53	79	A
45	221	F	53	79	A
46	222	F	53	79	A
47	224	M	11	54	A
48	225	M	11	54	A
49	227	M	164	196	A
50	233	F	146	152	A

Table 5

RED WOLF
SSP POPULATION
GENE DROP ANALYSIS

9 JULY, 1989

0 = WILD; -1 = UNK

	ID	Sex	Sire	Dam	Status
51	242	M	52	195	A
52	243	F	52	195	A
53	244	F	52	195	D
54	245	F	52	195	A
55	247	M	11	54	A
56	248	F	11	54	A
57	251	F	146	216	A
58	252	F	146	216	A
59	253	F	146	216	A
60	255	M	137	112	A
61	268	M	53	79	A
62	269	F	53	79	A
63	270	F	53	79	A
64	272	M	11	54	A
65	277	F	34	132	A
66	278	F	34	132	A
67	279	F	34	132	D
68	280	M	213	244	A
69	282	M	213	244	A
70	289	F	213	244	A
71	291	M	213	244	A
72	292	M	213	244	A
73	293	M	213	244	A
74	294	M	24	196	A
75	297	F	24	196	A
76	299	M	227	194	A
77	300	F	227	194	A
78	301	F	227	194	A
79	302	F	227	194	A
80	303	F	227	194	A
81	304	F	227	194	A
82	305	F	227	194	A
83	312	M	242	279	A
84	313	F	242	279	A
85	315	F	242	279	A
86	316	F	242	279	A
87	319	M	52	142	A
88	321	F	179	245	A
89	322	F	179	245	A
90	323	F	179	245	A
91	324	F	179	245	A
92	325	F	179	245	A
93	327	M	179	245	A
94	328	M	179	245	A
95	331	M	242	279	A
96	332	M	242	279	A
97	351	F	184	205	A
98	347	F	280	269	A
99	350	M	280	269	A
100	349	M	280	269	A

Table 5 (Cont.)

RED WOLF
SSP POPULATION
GENE DROP ANALYSIS

9 JULY, 1989

0 = WILD; -1 = UNK

	ID	Sex	Sire	Dam	Status
101	348	F	280	269	A
102	336	M	213	245	A
103	338	F	213	245	A
104	335	M	213	245	A
105	344	F	211	196	A
106	337	F	213	245	A
107	339	F	213	245	A
108	346	M	291	289	A
109	342	F	268	215	A
110	341	M	268	215	A
111	352	M	219	303	A
112	353	M	219	303	A
113	354	M	219	303	A
114	356	M	293	301	A
115	357	M	293	301	A
116	358	M	293	301	A
117	359	M	293	301	A
118	360	F	293	301	A
119	361	F	293	301	A
120	362	M	268	277	A
121	363	F	268	277	A
122	364	F	268	277	A
123	368	M	291	233	A
124	369	M	291	233	A
125	371	F	291	233	A
126	372	M	280	245	A
127	373	M	280	245	A
128	374	M	280	245	A
129	375	F	280	245	A
130	376	F	280	245	A
131	377	F	280	245	A
132	378	F	280	245	A
133	379	F	242	289	A
134	380	F	242	289	A
135	381	F	242	289	A
136	382	F	242	289	A
137	383	F	242	289	A
138	386	M	212	195	A
139	387	M	212	195	A
140	388	F	212	195	A
141	389	F	212	195	A
142	390	F	212	195	A
143	391	F	212	195	A
144	392	M	227	205	A
145	393	F	227	205	A
146	394	F	227	205	A
147	395	F	227	205	A

119 Living Descendants 147 In total pedigree

Table 5 (Cont.)

RED WOLF
SSP POPULATION
FOUNDER ALLELE REPRESENTATION

10 JULY, 1989

FOUNDER	RETENTION	% REPRESENTATION	TARGET	DIFFERENCE
6M	0.978	18.913	9.385	-9.528
8M	0.866	13.713	8.310	-5.402
11M	0.996	4.620	9.553	4.933
12F	0.942	16.546	9.035	-7.512
13F	0.899	12.156	8.627	-3.529
14F	0.931	6.946	8.934	1.988
16F	0.500	3.453	4.798	1.345
17M	0.235	0.198	2.260	2.062
24M	0.997	11.846	9.562	-2.284
26M	0.470	2.368	4.510	2.142
30F	0.500	0.420	4.798	4.378
33M	0.744	4.722	7.135	2.412
34M	0.899	2.956	8.627	5.671
42M	0.466	1.142	4.467	3.325

Table 6

GENETIC SUMMARY

	LIVING DESCENDANT POPULATION	POTENTIAL
Number of founders:	14	14
Parity (%):	7.143	7.143
Mean retention :	0.744	0.744
Founder Genomes Surviving :	10.421	10.421
Founder Genomes Equivalents :	7.513	10.421
Founder Equivalents :	8.148	12.619
Fraction of wild heterozygosity retained :	0.906	0.952
Fraction of wild heterozygosity lost :	0.094	0.048
Mean inbreeding coefficient realized :	0.041	

Table 7

GENETICS GLOSSARY

GENOME

The complete set of genes (alleles) carried by an individual.

RETENTION

Fraction of founder's original set of genes (genomes) still present in the population.

EXSISTING REPRESENTATION

The existing percentage representation of founders in the population.

TARGET REPRESENTATION

The desired target percentage representation of founders. These target figures are proportional to the fraction of each founder genome that survived. Achieving these target representation values will maximize preservation of genetic diversity.

DIFFERENCE

(Existing Representation) - (Target Representation)

A minus sign (-) designates a founder that is over - represented.

POTENTIAL FOUNDER

An animal from a source population (e.g., the wild) that establish a derived population (e.g., a captive or new wild population).

FOUNDER

An animal form a source (e.g., wild) population that actually produced offspring and have descendants in the living derived (e.g., captive) population.

The minus sign (-) designates the unknown mate of the founder with that number.

MEAN RETENTION

Average fraction of each founder genome surviving in the population.

MEAN HETEROZYGOSITY

Average fraction of original heterozygosity remaining in the population.

BOTTLENECK

A generation in the lineage from a founder when only one or a few offspring are produced so that not all of the founder's alleles are transmitted onto the next generation.

FOUNDER GENOME SURVIVING

The sum of the allelic retention; i.e., the number of founder genomes still in the population. This metric measure loss of original diversity due to bottlenecks in the pedigree of the population.

FOUNDER GENOME EQUIVALENTS

The number of newly wild caught animals required to obtain the genetic diversity in the present captive population. This metric reflects loss due to both bottlenecks and disparities in the founder representation.

3. The third way is for the representation of the founders in the living population to be very disparate. Even though some fraction of the genome (original alleles) of a founder may be surviving, the actual number of copies of each founder's alleles currently present in the population is also very important. If some founder alleles are very common in the population, but others are very rare, the effective number of founders will be reduced because there is a high risk that the less common alleles will soon be lost. Founders have not contributed equally to the red wolf population (Table 6 and Figure 4). Representation of founders can be redressed to a substantial extent by regulating reproduction of their descendants.

   Founder Genome Equivalents adds these reductions to the loss due to bottlenecks (i.e., Founder Genomes Surviving) to estimate the actual effective numbers of founders in the living population. If management acts to rectify the disparities in founder distribution (i.e., so the founder representation in the population moves from the existing to the target distribution), the effective number of founders can be increased from the Founder Genome Equivalents level to the Number of Founder Genomes Surviving.

As a consequence of factors 2 and 3, the number of effective founders for the red wolf population is currently about 8 but could be increased to about 12.6 through better management to reduce disparities in founder lineage representation. It is estimated that about 91 percent of the original heterozygosity in the wild population is still present in the captive population under existing management. This level could be increased to 95 percent if management is improved.

Employing the data provided by the previous genetic and demographic analysis and using a software program developed by Dr. Jonathan Ballou, a PVA has been performed relative to genetic considerations to estimate MVPs necessary for various objectives (Tables 8a-g). Even with conservative case scenarios relative to parameters (effective founder number of 8, an N_e/N ratio of 0.3, a generation time of 6 years, and an annual growth rate [lambda] of 10 percent), it has been calculated that a captive population of 320 animals and a reintroduced wild population of 220 red wolves would be able to maintain 80 to 85 percent of the original genetic diversity from the captured wild stock that probably occurred in the wild gene pool of red wolves. Retention of 80 to 85 percent of original heterozygosity is equivalent to preserving at least 90 percent of the heterozygosity that still exists (i.e., 90 percent of the 92 to 95 percent of the original that still exists).

The current population of red wolves is reproducing reliably but cannot be considered a self-sustaining population because of the low total numbers. Animals can be moved to reproductive situations almost as quickly as new captive habitats are provided. However,

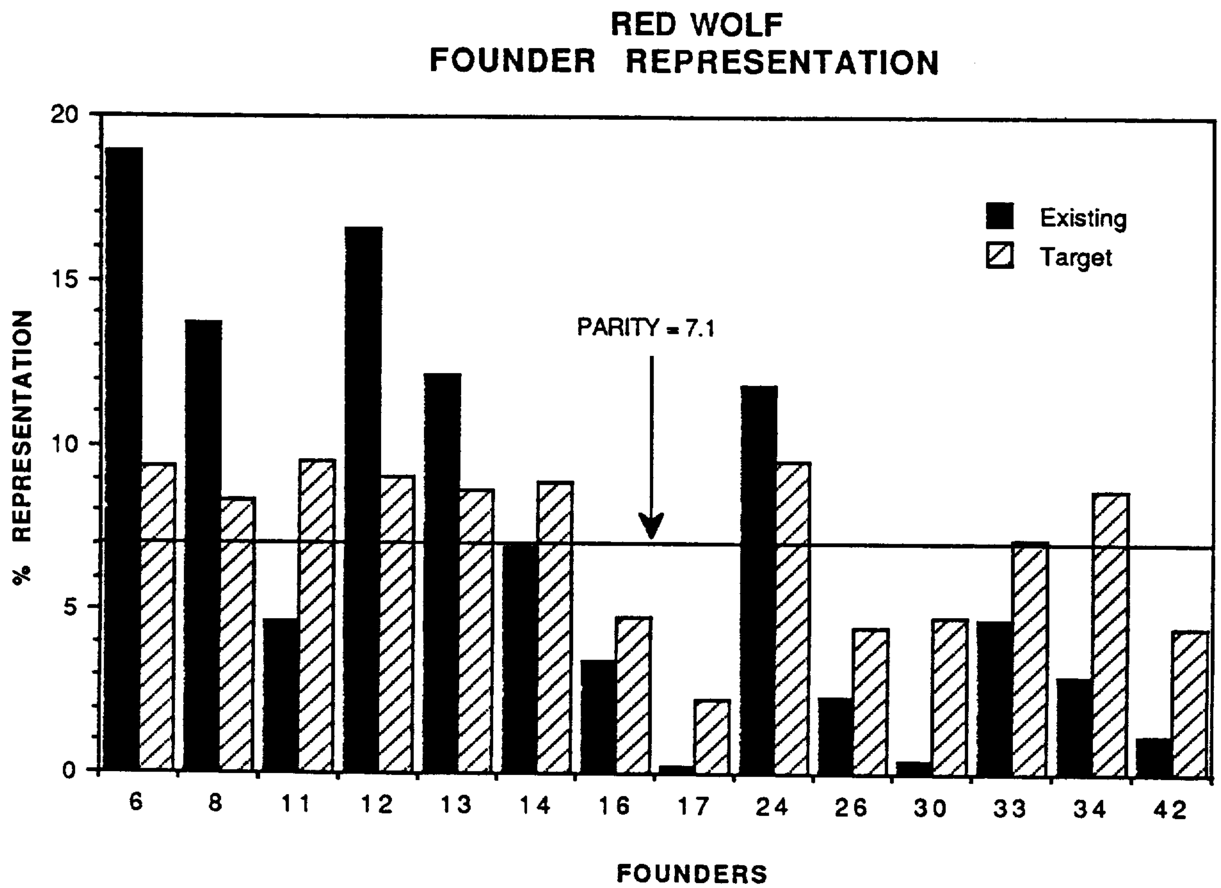

RED WOLF
FOUNDER REPRESENTATION
20
15
10
5
0
% REPRESENTATION
Existing
Target
PARITY = 7.1
6
8
11
12
13
14
16
17
24
26
30
33
34
42
FOUNDERS

Figure 4

RED WOLF
CALCULATIONS FOR CARRYING CAPACITY

Capacity 2.11

Effective Size and Carrying Capacity Necessary for Maintaining the
Specified Amount of Genetic Diversity for the Specified Amount of Time

Number of Years per Generation :	6.0	# Generation during 200 Years :	33
Yearly Growth Rate (lambda) :	1.100	Exponential Growth Rate (r) :	0.095
Effective Number of Founders :	10	Growth rate per Generation :	1.772
Estimated Ne/N Ratio :	0.40	Exponential Growth/Generation :	0.572
Desired % Hetero. Retain :	80.0		
Length of Time Period (Years):	200		

Effective Size Required to Maintain 80.0% of the
Original Founder's Heterozygosity for 200 Years: 124

Actual Carrying Capacity Required (Based on Ne/N Ratio) : 310

— 07/10/89 —— j. ballou-NZP Mar' 89 —

Table 8a

RED WOLF
CALCULATIONS FOR CARRYING CAPACITY

Capacity 2.11

Actual Carrying Capacity Required to Maintain 80.0% of the Original Heterozygosity for Different Founder #s Under Various Ne/N Ratios

No. EFFECTIVE FOUNDERS

		7	8	9	10	11
Ne/N Ratio	0.30	747	553	463	413	380
	0.40	560	415	348	310	285
	0.50	448	332	278	248	228
	0.60	373	277	232	207	190
	0.70	320	237	199	177	163

Table Parameters	
Lambda :	1.100
Gen. Length :	6.0
Time Period :	200

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Table 8b

Capacity 2.11

Actual Carrying Capacity Required to Maintain 80.0% of the Original Heterozygosity for Various Time Periods Under Various Ne/N Ratios

LENGTH OF PROGRAM (YEARS)

		50	100	150	175	200
Ne/N Ratio	0.30	70	170	297	353	413
	0.40	53	128	223	265	310
	0.50	42	102	178	212	248
	0.60	35	85	148	177	207
	0.70	30	73	127	151	177

Table Parameters	
Lambda :	1.100
Gen. Length :	6.0
No. Fndrs :	10

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Table 8c

RED WOLF
CALCULATIONS FOR CARRYING CAPACITY

Capacity 2.11

Actual Carrying Capacity Required to Maintain 80.0% of the Original Heterozygosity for Various Time Periods Given Various Founder Numbers

LENGTH OF PROGRAM (YEARS)

		50	100	150	175	200
No. Effective Founders	7	75	213	393	475	560
	8	63	165	295	355	415
	9	58	143	250	300	348
	10	53	128	223	265	310
	11	50	120	205	245	285

Table Parameters

Lambda :	1.100
Gen. Length :	6.0
Ne/N Ratio :	0.40

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Table 8d

Capacity 2.11

Actual Carrying Capacity Required to Maintain Various Levels of Heterozygosity for 200 Years with Various Numbers of Founders

PERCENT HETEROZYGOSITY RETAINED

		70.0	75.0	80.0	85.0	90.0
No. Effective Founders	7	178	273	560	****	****
	8	163	235	415	1783	****
	9	153	213	348	930	****
	10	145	200	310	683	****
	11	140	190	285	563	****

Table Parameters

Lambda :	1.100
Gen. Length :	6.0
Ne/N Ratio :	0.40

**** = Not possible with these parameters

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Table 8e

RED WOLF
CALCULATIONS FOR CARRYING CAPACITY

Capacity 2.11

Actual Carrying Capacity Required to Maintain Various Levels of Heterozygosity for Various Ne/N Ratios for 200 Years

PERCENT HETEROZYGOSITY TO RETAIN

		70.0	75.0	80.0	85.0	90.0
Ne/N Ratio	0.30	193	267	413	910	****
	0.40	145	200	310	683	****
	0.50	116	160	248	546	****
	0.60	97	133	207	455	****
	0.70	83	114	177	390	****

Table Parameters

Lambda :	1.100
Gen. Length :	6.0
No. Fndrs :	10

**** = Not possible with these parameters

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Table 8f

Capacity 2.11

Actual Carrying Capacity Required to Maintain Various Levels of Heterozygosity for Various Time Periods Given 10 Effective Founders

LENGTH OF PROGRAM (YEARS)

		50	100	150	175	200
Percent Heter. Retained	70.0	30	65	105	125	145
	75.0	38	85	145	173	200
	80.0	53	128	223	265	310
	85.0	95	263	480	580	683
	90.0	****	****	****	****	****

Table Parameters

Lambda :	1.100
Gen. Length :	6.0
Ne/N Ratio :	0.40

**** = Not possible with these parameters

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Table 8g

many more captive spaces must be provided if the species is expected to retain the current level of genetic diversity.

It is interesting to note that gray wolves in captivity number 321 animals (160 male and 161 female) in 49 facilities throughout North America, and the coyote numbers 59 animals (26 male and 33 female) in 30 facilities. Perhaps some of these spaces could accommodate red wolves as they become available for various reasons.

The Goal of the SSP Population

The propagation goal of the Service's Red Wolf Recovery Team and the Red Wolf SSP Propagation Group for the red wolf is to maintain 80 to 85 percent of the genetic diversity found in the original founder stock for a period of 150 plus years. This goal is equivalent to preserving 90 percent of the heterozygosity present in the existing captive population.

As derived pursuant to the above, a captive population of 330 wolves and a reintroduced wild population of 220 wolves are needed to achieve this goal. It is assumed that a captive population of 330 will have an effective population (N_e) of 125, and a wild population will have an N_e of 75. It is also assumed that various factors affecting MVP determination do not deteriorate further; e.g., more bottleneck loss of founder genes, decline in N_e/N ratios, or growth rate.

An important objective in this regard is to adjust the representation of founder lineages from the existing to the target distribution, requiring that, during this period of adjustment, representatives of under-represented founder lineages be reproduced more than representatives of over-represented founders. A summary measure to identify which animals represent under-represented versus over-represented founders is provided by the Founder Importance Coefficient of each animal (Figure 5 and Supplement).

Once founder distribution is adjusted, it will then be important to maximize effective population size (N_e) by regulating family sizes. N_e can also be increased immediately by maximizing recruitment of animals as breeders.

Because the captive population is approximately one-third of what is needed, and because the wild population is currently less than 2 percent of estimated need, there must be maximum expansion of the population over the next several years.

Red wolves are monestrous and typically persist as monogamous pairs. The mean litter size for the species is five. These parameters will determine the number of pairs breeding per year, which equals the number of enclosures where breeding occurs in that year after a target production level has been established in any given year. To achieve the above goals, it is calculated that 84 births are needed

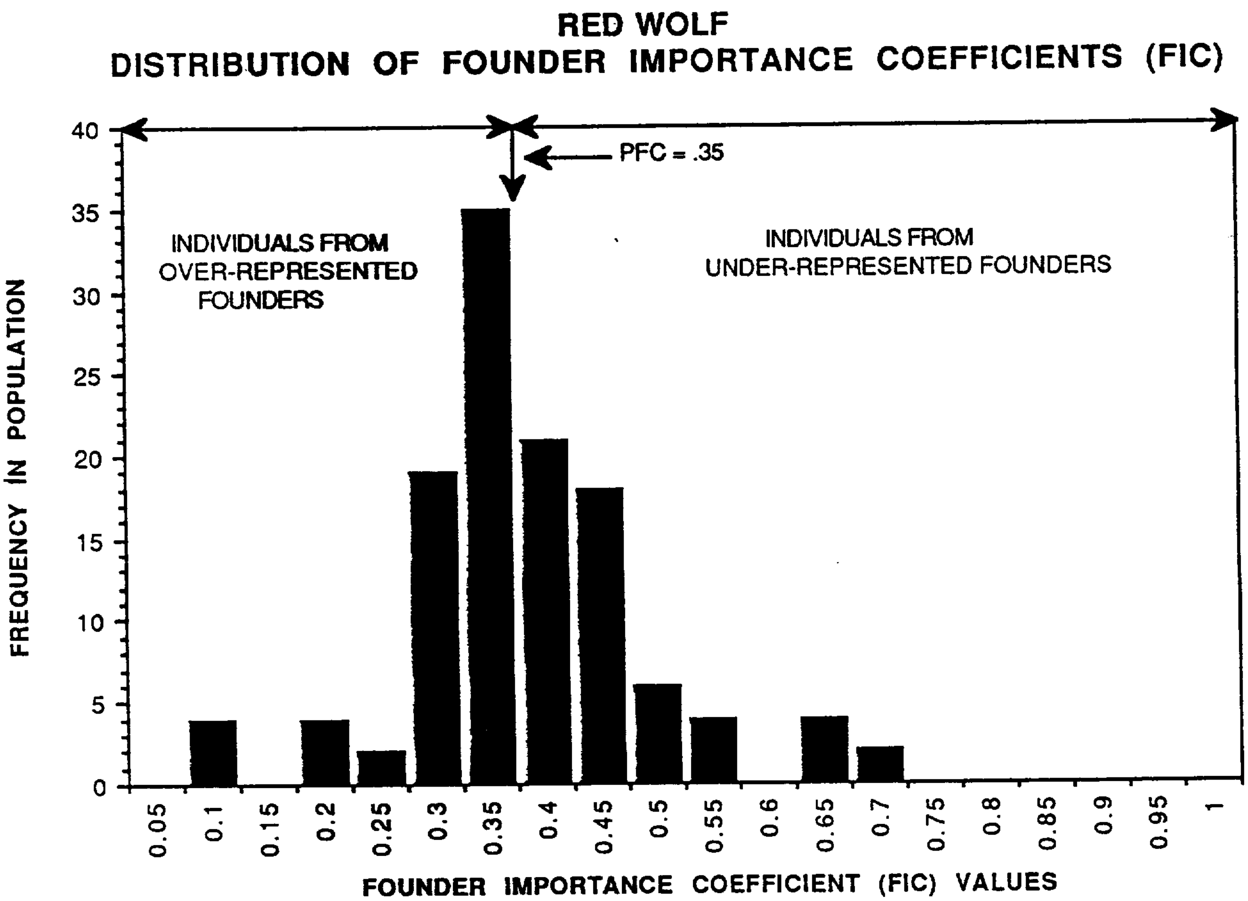
RED WOLF
DISTRIBUTION OF FOUNDER IMPORTANCE COEFFICIENTS (FIC)
PFC = .35
INDIVIDUALS FROM OVER-REPRESENTED FOUNDERS
INDIVIDUALS FROM UNDER-REPRESENTED FOUNDERS
FREQUENCY IN POPULATION
0
5
10
15
20
25
30
35
40
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
FOUNDER IMPORTANCE COEFFICIENT (FIC) VALUES

Figure 5

Figure 5 Supplement

RED WOLF

FOUNDER IMPORTANCE COEFFICIENT (FIC)

The Founder Importance Coefficient (FIC) can be used to initially identify individuals as being descended from over versus under-represented founders. Individuals who are descendants from over-represented founders will have low Founder Importance Coefficients; those that are descendants from under-represented founders will have high Founder Importance Coefficients. The Founder Importance Coefficient is the weighted- average of an individual's founder contributions with the overall population founder contributions acting as the weights. The weighted average is standardized so that it ranges between 0 and 1. If the most over-represented founder is still alive, it will have a Founder Coefficient of 0; the most under-represented founder (if alive) will have a Founder Coefficient of 1.0.

The FIC is the weighted average of all the founder contributions to that individual with the weights being the overall founder contribution of each founder to the SSP population:

$$FIC_i = \sum_{j=1}^{NF} (OFC_j * FC_{ij})$$

where: OFC_i is the Overall Founder Contribution of Founder j to the SSP population.

FC_{ij} is the representation of founder j to individual i.

NF is the total number of founders.

The values are then standardized as follows:

$$\text{Std FIC} = \frac{(MAX - FIC)}{(MAX - MIN)}$$

where: FIC is as described above.

MAX is the Maximum FIC and is the OFC for the most over-represented founder.

MIN is the Minimum FIC and is the OFC for the most under-represented founder.

- -

POPULATION FOUNDER COEFFICIENT (PFC)

The Population Founder Contribution (PFC) is the Founder Importance Coefficient of a hypothetical individual whose founder contributions are equal to the actual contributions of each founder in the population. Therefore, individuals with Founder Importance Coefficients higher than the PFC are descendants of under-represented founders and those with lower Founder Importance Coefficients are descendants of over-represented founders.

In the case of the red wolf an individual with founder contributions equal to the Population Founder Contribution (PFC) will have a Founder Importance Coefficient of .35. Individuals in the population with Founder Importance Coefficients > .35 are carrying genes that may help the population reach the Target Founder Contribution goal, those with Founder Importance Coefficients < .35 may not significantly contribute toward achieving this goal.

per year for the next 5 years. Given a mean litter size of five, this means that 17 litters must be produced per year (Table 9).

Captive habitat should be increased by increasing the number of widely separated captive facilities and by upgrading existing facilities. There are two reasons for this. First and foremost, this will help minimize stochastic problems experienced by small populations due to demographic, environmental, and genetic uncertainty. Second, each participating SSP institution will increase public awareness of the red wolf recovery program by local and regional residents by virtue of pup births and accompanying local media stories and by education/outreach programs. A minimum of 20 to 25 new facilities, as well as the expansion of existing facilities, is necessary to accommodate 250 additional animals in the captive-population program. Also, a substantial number of additional Federal or State wildlife management units will have to be recruited to manage the 220 free-ranging wolves needed to maintain genetic diversity over the long term.

Clearly, the goals of this program are dependent upon the availability of suitable wild and captive habitats and the continued cooperation and active support from local, State, and Federal agencies, zoos, and the residents surrounding potential and existing reintroduction sites.

Specific Objectives

Using the rationale outlined above, specific objectives have been developed to serve as guidelines in establishing institution-by-institution and animal-by-animal recommendations. These objectives are:

1. Develop a captive population of at least 330 animals and a wild population of at least 220 animals in order to preserve 80 to 85 percent of the average heterozygosity of the original wild population (equivalent to 90 percent of the existing heterozygosity in the captive population) for the next 150 plus years.

2. Maintain a stable, self-sustaining population of red wolves in captivity and in the wild.

3. Continue the evaluation of the taxonomic status of the red wolf with a review of current literature. Determine, through mitochondrial DNA analysis and other biochemical techniques, the status of *Canis rufus* in the family Canidae.

4. As the captive population increases, design and implement complete reproductive physiology studies.

5. Adjust founder lineage representation from the existing to the target distribution.

RED WOLF
BIRTH LIMITS

9 JULY 1989

Number of births required to maintain a stationary population at a given carrying capacity.

CARRYING CAPACITY			BIRTHS REQUIRED		
MALES	FEMALES	TOTAL	MALES	FEMALES	TOTAL
25	25	50	6	7	13
50	50	100	12	14	26
75	75	150	18	22	40
100	100	200	24	29	53
125	125	250	31	36	67
150	150	300	37	44	81
175	175	350	43	51	94
200	200	400	49	58	107

Table 9

6. Increase the number of effective founders from 8 to 10.5.

7. Improve N_e/N from the existing 0.1-0.3 to 0.4.

8. Expand the carrying capacity of the Graham breeding facility to at least double its present capacity.

9. Recruit at least 25 new facilities with captive habitats to accommodate 140 additional red wolves.

10. Require each captive holding/propagation facility to house a minimum of 2.2 red wolves and their offspring until they can be placed in other facilities.

11. Provide at least 12 animals every other year for reintroduction purposes for the next 5 years.

12. Develop a model by which the Service can predict the approximate number of red wolves needed for each reintroduction site.

13. Evaluate completely all nonreproductive animals to ascertain cause of reproductive inactivity.

14. Monitor a release program for potential interactions of red wolves with other species, especially <u>Canis latrans</u>.

15. Develop a sperm- and embryo-banking strategy and initiate an active program with a qualified facility.

Following is an animal-by-animal distribution list of living red wolves as of August 1990.

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
1	F	WILD	WILD	01.04.66	18.02.75		TACOMA	USA	13.02.69	9C6	0001	SSP	0	0	107 M
							TACOMA	USA NA	13.02.69						
2	M	WILD	WILD	01.04.67	12.07.81		TACOMA	USA	12.07.81	76103	0019	SSP	0	0	171 M
							TACOMA	USA NA	31.08.76						
3	M	WILD	WILD	01.04.68	11.07.80		TACOMA	USA	20.02.71	2010	0003	SSP	0	0	147 M
							TACOMA	USA NA	20.02.71						
4	F	WILD	WILD	01.04.68	15.12.76		TACOMA	USA	19.10.74	74098	0008	SSP	0	0	104 M
							TACOMA	USA NA	19.10.74						
5	F	WILD	WILD	01.04.69	26.01.79		TACOMA	USA	02.05.77	77022	0030	SSP	0	0	118 M
							TACOMA	USA NA	02.05.77						
6	M	WILD	WILD	01.04.70	23.06.82		TACOMA	USA	06.02.74	74001	0004	SSP	0	0	147 M
							TACOMA	USA NA	06.02.74						
7	F	WILD	WILD	01.04.70	23.04.79		TACOMA	USA	03.11.70	1099	0002	SSP	0	0	109 M
							TACOMA	USA NA	03.11.70						
8	M	WILD	WILD	01.04.71	26.04.85		TACOMA	USA	31.07.74	74093	0006	SSP	0	0	169 M
							TACOMA	USA NA	31.07.74						
9	M	WILD	WILD	01.04.71	08.04.75		TACOMA	USA	12.10.74	74102	0007	SSP	0	0	48 M
							TACOMA	USA NA	12.10.74						
10	M	WILD	WILD	01.04.71	31.03.78		TACOMA	USA	21.01.76	76044	0010	SSP	0	0	84 M
							TACOMA	USA NA	21.01.76						
11	M	WILD	WILD	01.04.71	11.11.88		TACOMA	USA	30.09.75	75114	0015	SSP	0	0	211 M
							WCSRC	USA NA	20.10.81						
12	F	WILD	WILD	01.04.71	17.03.83		TACOMA	USA	06.02.74	74002	0005	SSP	0	0	144 M
							TACOMA	USA NA	06.02.74						
13	F	WILD	WILD	01.04.71	01.05.81		TACOMA	USA	28.02.75	75016	0012	SSP	0	0	121 M
							TACOMA	USA NA	28.02.75						
14	F	WILD	WILD	01.04.71	03.09.81		TACOMA	USA	31.08.76	76102	0018	SSP	0	0	125 M
							TACOMA	USA NA	31.08.76						
15	F	WILD	WILD	01.04.71	28.07.82		TACOMA	USA	03.10.76	76123	0020	SSP	0	0	136 M
							TACOMA	USA NA	03.10.76						
16	F	WILD	WILD	01.04.71	25.11.78		TACOMA	USA	06.10.76	76124	0022	SSP	0	0	92 M
							TACOMA	USA NA	06.10.76						
17	M	WILD	WILD	01.04.72	22.12.80		TACOMA	USA	02.02.75	75012	0009	SSP	0	0	105 M
							TACOMA	USA NA	02.02.75						
18	M	WILD	WILD	01.04.72	07.08.82		DR. LONG	USA	26.02.75	75015	0013	SSP	0	0	124 M
							DR. LONG	USA NA	26.02.75						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
19	M	WILD	WILD	01.04.72	03.04.81		TACOMA	USA	21.02.76	75081	0014	SSP	0	0	108 M
							TACOMA	USA NA	21.02.76						
20	M	WILD	WILD	01.04.72	15.12.76		TACOMA	USA	03.10.76	76132	0021	SSP	0	0	56 M
							TACOMA	USA NA	03.10.76						
21	M	WILD	WILD	01.04.72	15.12.77		DR. LONG	USA	18.11.77	77072	0037	SSP	0	0	68 M
							DR. LONG	USA NA	18.11.77						
22	F	WILD	WILD	01.04.72	01.04.77		TACOMA	USA	21.01.76	76045	0011	SSP	0	0	60 M
							TACOMA	USA NA	21.01.76						
23	F	WILD	WILD	01.04.72	28.06.77		TACOMA	USA	03.10.76	76131	0023	SSP	0	0	63 M
							TACOMA	USA NA	03.10.76						
24	M	WILD	WILD	01.04.73	17.06.89		TACOMA	USA	20.04.76	76058	0017	SSP	0	0	195 M
							TACOMA	USA NA	20.04.76						
25	M	WILD	WILD	01.04.73	21.08.80		TACOMA	USA	21.01.77	77007	0027	SSP	0	0	89 M
							TACOMA	USA NA	21.01.77						
26	M	WILD	WILD	01.04.73	22.01.85		DR. LONG	USA	17.03.77	77045	0032	SSP	0	0	142 M
							TACOMA	USA NA	16.06.80						
27	M	WILD	WILD	01.04.73	09.09.77		DR. LONG	USA	27.04.77	77051	0035	SSP	0	0	53 M
							DR. LONG	USA NA	27.04.77						
28	M	WILD	WILD	01.04.73	12.08.79		DR. LONG	USA	18.11.77	77073	0038	SSP	0	0	76 M
							TACOMA	USA NA	09.01.79						
29	F	WILD	WILD	01.04.73	08.11.79		TACOMA	USA	04.11.75	75118	0016	SSP	0	0	79 M
							TACOMA	USA NA	04.11.75						
30	F	WILD	WILD	01.04.73	05.11.80		TACOMA	USA	01.02.77	77019	0028	SSP	0	0	91 M
							TACOMA	USA NA	01.02.77						
31	F	WILD	WILD	01.04.73	06.04.81		DR. LONG	USA	17.03.77	77044	0031	SSP	0	0	96 M
							DR. LONG	USA NA	17.03.77						
32	F	WILD	WILD	01.04.73	15.11.78		DR. LONG	USA	28.03.78	78031	0039	SSP	0	0	67 M
							DR. LONG	USA NA	28.03.78						
33	M	WILD	WILD	01.04.74	09.07.81		TACOMA	USA	04.02.77	77021	0029	SSP	0	0	87 M
							TACOMA	USA NA	04.02.77						
34	M	WILD	WILD	01.04.74	12.03.87		TACOMA	USA	03.10.79	79046	0127	SSP	0	0	155 M
							TACOMA	USA NA	03.10.79						
35	F	WILD	WILD	01.04.74	02.07.84		TACOMA	USA	19.03.78	78028	0033	SSP	0	0	123 M
							TACOMA	USA NA	19.03.78						
36	F	WILD	WILD	01.04.74	04.03.79		DR. LONG	USA	27.04.77	77052	0036	SSP	0	0	59 M
							DR. LONG	USA NA	27.04.77						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
37	F	WILD	WILD	01.04.74	12.06.80		DR. LONG	USA	29.06.75	76058	0245	SSP	0	0	74 M
							DR. LONG	USA NA	29.06.75						
38	M	WILD	WILD	01.04.75	21.07.78		TACOMA	USA	07.01.78	77002	0026	SSP	0	0	40 M
							TACOMA	USA NA	07.01.78						
39	M	WILD	WILD	01.04.75	18.07.79		TACOMA	USA	27.04.77	77050	0034	SSP	0	0	52 M
							TACOMA	USA NA	27.04.77						
40	F	WILD	WILD	01.04.75	15.07.78		DR. LONG	USA	03.10.76	76133	0024	SSP	0	0	39 M
							DR. LONG	USA NA	03.10.76						
41	F	WILD	WILD	01.04.75	21.07.78		TACOMA	USA	06.01.77	77001	0025	SSP	0	0	40 M
							TACOMA	USA NA	06.01.77						
42	M	WILD	WILD	01.04.76	05.02.81		TACOMA	USA	06.04.78	78041	0040	SSP	0	0	58 M
							TACOMA	USA NA	06.04.78						
43	U	18	40	03.05.77	14.05.77		DR. LONG	USA	03.05.77		0239	SSP	59	25	11 D
							DR. LONG	USA NA	03.05.77						
44	M	18	40	03.05.77	01.08.78		DR. LONG	USA	03.05.77	77061	0240	SSP	59	25	15 M
							DR. LONG	USA NA	03.05.77						
45	F	18	40	03.05.77	03.05.78		DR. LONG	USA	03.05.77	77062	0241	SSP	59	25	12 M
							DR. LONG	USA NA	03.05.77						
46	U	18	40	03.05.77	03.05.78		DR. LONG	USA	03.05.77		0238	SSP	59	25	12 M
							DR. LONG	USA NA	03.05.77						
47	M	8	23	04.05.77	05.05.77		TACOMA	USA	04.05.77		0041	SSP	71	61	1 D
							TACOMA	USA NA	04.05.77						
48	F	8	23	04.05.77	12.02.83		TACOMA	USA	04.05.77	WG1	0043	SSP	71	61	69 M
							TACOMA	USA NA	04.05.77						
49	U	8	23	04.05.77	12.05.77		TACOMA	USA	04.05.77		0042	SSP	71	61	8 D
							TACOMA	USA NA	04.05.77						
50	M	6	12	13.05.77	17.05.77		TACOMA	USA	13.05.77		0044	SSP	83	73	4 D
							TACOMA	USA NA	13.05.77						
51	M	6	12	13.05.77	19.01.79		TACOMA	USA	13.05.77	WG3	0047	SSP	83	73	20 M
							TACOMA	USA NA	13.05.77						
52	M	6	12	13.05.77	22.12.89		TACOMA	USA	13.05.77	WG4	0048	SSP	83	73	151 M
							TACOMA	USA NA	13.05.77						
53	M	6	12	13.05.77	09.05.85		TACOMA	USA	13.05.77	WG5	0049	SSP	83	73	96 M
							AUDUBON	USA NA	30.10.80						
54	F	6	12	13.05.77	22.11.89		TACOMA	USA	13.05.77	WG2	0046	SSP	83	73	150 M
							WCSRC	USA NA	20.10.81						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
55	U	6	12	13.05.77	15.05.77		TACOMA	USA	13.05.77		0045	SSP	83	73	2 D
							TACOMA	USA NA	13.05.77						
56	M	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG10	0054	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
57	M	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG11	0055	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
58	F	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG6	0050	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
59	F	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG7	0051	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
60	F	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG8	0052	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
61	F	2	14	16.05.77	21.07.78		TACOMA	USA	16.05.77	WG9	0053	SSP	120	74	14 M
							TACOMA	USA NA	16.05.77						
62	M	3	7	23.05.77	01.05.79		TACOMA	USA	23.05.77	WG13	0057	SSP	108	86	23 M
							TACOMA	USA NA	23.05.77						
63	M	3	7	23.05.77	14.02.78		TACOMA	USA	23.05.77	WG14	0058	SSP	108	86	9 M
							TACOMA	USA NA	23.05.77						
64	F	3	7	23.05.77	21.07.78		TACOMA	USA	23.05.77	WG12	0056	SSP	108	86	14 M
							TACOMA	USA NA	23.05.77						
65	F	WILD	WILD	01.04.78	24.07.85		TACOMA	USA	23.03.80	80019	0246	SSP	0	0	88 M
							TACOMA	USA NA	23.03.80						
66	F	WILD	32	20.04.78	10.01.79		DR. LONG	USA	20.04.78	78074	0242	SSP	0	61	9 M
							DR. LONG	USA NA	20.04.78						
67	F	WILD	32	20.04.78	15.05.78		DR. LONG	USA	20.04.78		0243	SSP	0	61	25 D
							DR. LONG	USA NA	20.04.78						
68	M	28	40	25.04.78	15.01.79		DR. LONG	USA	25.04.78	78075	0073	SSP	59	37	9 M
							DR. LONG	USA NA	25.04.78						
69	U	28	40	25.04.78	25.05.78		DR. LONG	USA	25.04.78		0070	SSP	59	37	1 M
							DR. LONG	USA NA	25.04.78						
70	U	28	40	25.04.78	25.05.78		DR. LONG	USA	25.04.78		0071	SSP	59	37	1 M
							DR. LONG	USA NA	25.04.78						
71	U	28	40	25.04.78	25.05.78		DR. LONG	USA	25.04.78		0072	SSP	59	37	1 M
							DR. LONG	USA NA	25.04.78						
72	M	18	36	28.04.78	01.10.80		DR. LONG	USA	28.04.78	78077	0089	SSP	71	49	29 M
							DR. LONG	USA NA	28.04.78						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
73	F	18	36	28.04.78	23.04.80		DR. LONG	USA	28.04.78	78076	0088	SSP	71	49	24 M
							DR. LONG	USA NA	28.04.78						
74	U	18	36	28.04.78	01.05.78		DR. LONG	USA	28.04.78		0090	SSP	71	49	3 D
							DR. LONG	USA NA	28.04.78						
75	U	17	29	05.05.78	20.05.78		TACOMA	USA	05.05.78		0059	SSP	71	61	15 D
							TACOMA	USA NA	05.05.78						
76	U	17	29	05.05.78	23.05.78		TACOMA	USA	05.05.78		0060	SSP	71	61	18 D
							TACOMA	USA NA	05.05.78						
77	U	17	29	05.05.78	06.06.78		TACOMA	USA	05.05.78		0061	SSP	71	61	1 M
							TACOMA	USA NA	05.05.78						
78	U	17	29	05.05.78	14.06.78		TACOMA	USA	05.05.78		0062	SSP	71	61	1 M
							TACOMA	USA NA	05.05.78						
79	F	8	16	05.05.78	21.04.90		TACOMA	USA	05.05.78	WG17	0095	SSP	83	85	144 M
							TACOMA	USA NA	02.12.88						
80	U	8	16	05.05.78	06.05.78		TACOMA	USA	05.05.78		0091	SSP	83	85	1 D
							TACOMA	USA NA	05.05.78						
81	U	8	16	05.05.78	06.05.78		TACOMA	USA	05.05.78		0092	SSP	83	85	1 D
							TACOMA	USA NA	05.05.78						
82	U	8	16	05.05.78	06.05.78		TACOMA	USA	05.05.78		0093	SSP	83	85	1 D
							TACOMA	USA NA	05.05.78						
83	U	8	16	05.05.78	08.05.78		TACOMA	USA	05.05.78		0094	SSP	83	85	3 D
							TACOMA	USA NA	05.05.78						
84	M	33	15	10.05.78	01.05.84		TACOMA	USA	10.05.78	WG18	0081	SSP	47	85	72 M
							DR. LONG	USA NA	20.10.80						
85	M	33	15	10.05.78	09.08.79		TACOMA	USA	10.05.78	WG19	0082	SSP	47	85	15 M
							TACOMA	USA NA	10.05.78						
86	M	33	15	10.05.78	09.08.79		TACOMA	USA	10.05.78	WG20	0083	SSP	47	85	15 M
							TACOMA	USA NA	10.05.78						
87	F	33	15	10.05.78	27.02.79		TACOMA	USA	10.05.78	WG21	0084	SSP	47	85	10 M
							TACOMA	USA NA	10.05.78						
88	F	33	15	10.05.78	28.02.79		TACOMA	USA	10.05.78	WG22	0085	SSP	47	85	10 M
							TACOMA	USA NA	10.05.78						
89	F	33	15	10.05.78	09.08.79		TACOMA	USA	10.05.78	WG23	0086	SSP	47	85	15 M
							TACOMA	USA NA	10.05.78						
90	F	33	15	10.05.78	01.05.84		TACOMA	USA	10.05.78	WG24	0087	SSP	47	85	72 M
							DR. LONG	USA NA	20.10.80						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
91	U	24	30	16.05.78	22.05.78		TACOMA	USA	16.05.78		0063	SSP	60	62	6 D
							TACOMA	USA NA	16.05.78						
92	U	24	30	16.05.78	22.05.78		TACOMA	USA	16.05.78		0064	SSP	60	62	6 D
							TACOMA	USA NA	16.05.78						
93	U	24	30	16.05.78	22.05.78		TACOMA	USA	16.05.78		0065	SSP	60	62	6 D
							TACOMA	USA NA	16.05.78						
94	F	6	12	16.05.78	05.04.82		TACOMA	USA	16.05.78	WG25	0101	SSP	96	86	47 M
							TACOMA	USA NA	16.05.78						
95	U	6	12	16.05.78	19.05.78		TACOMA	USA	16.05.78		0096	SSP	96	86	3 D
							TACOMA	USA NA	16.05.78						
96	U	6	12	16.05.78	19.05.78		TACOMA	USA	16.05.78		0097	SSP	96	86	3 D
							TACOMA	USA NA	16.05.78						
97	U	6	12	16.05.78	21.05.78		TACOMA	USA	16.05.78		0098	SSP	96	86	5 D
							TACOMA	USA NA	16.05.78						
98	U	6	12	16.05.78	22.05.78		TACOMA	USA	16.05.78		0099	SSP	96	86	6 D
							TACOMA	USA NA	16.05.78						
99	U	6	12	16.05.78	24.06.78		TACOMA	USA	16.05.78		0100	SSP	96	86	1 M
							TACOMA	USA NA	16.05.78						
100	M	3	7	18.05.78	07.11.78		TACOMA	USA	18.05.78	WG16	0080	SSP	120	98	6 M
							TACOMA	USA NA	18.05.78						
101	F	3	7	18.05.78	28.02.79		TACOMA	USA	18.05.78	WG15	0079	SSP	120	98	9 M
							TACOMA	USA NA	18.05.78						
102	U	3	7	18.05.78	18.06.78		TACOMA	USA	18.05.78		0074	SSP	120	98	1 M
							TACOMA	USA NA	18.05.78						
103	U	3	7	18.05.78	18.06.78		TACOMA	USA	18.05.78		0075	SSP	120	98	1 M
							TACOMA	USA NA	18.05.78						
104	U	3	7	18.05.78	18.06.78		TACOMA	USA	18.05.78		0076	SSP	120	98	1 M
							TACOMA	USA NA	18.05.78						
105	U	3	7	18.05.78	18.06.78		TACOMA	USA	18.05.78		0077	SSP	120	98	1 M
							TACOMA	USA NA	18.05.78						
106	U	3	7	18.05.78	18.06.78		TACOMA	USA	18.05.78		0078	SSP	120	98	1 M
							TACOMA	USA NA	18.05.78						
107	U	2	13	25.05.78	14.07.78		TACOMA	USA	25.05.78		0066	SSP	132	86	2 M
							TACOMA	USA NA	25.05.78						
108	U	2	13	25.05.78	14.07.78		TACOMA	USA	25.05.78		0067	SSP	132	86	2 M
							TACOMA	USA NA	25.05.78						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
109	U	2	13	25.05.78	14.07.78		TACOMA	USA	25.05.78		0068	SSP	132	86	2 M
							TACOMA	USA WA	25.05.78						
110	U	2	13	25.05.78	14.07.78		TACOMA	USA	25.05.78		0069	SSP	132	86	2 M
							TACOMA	USA WA	25.05.78						
111	F	33	14	28.04.79	. .		TACOMA	USA	28.04.79	WG30	0114	SSP	59	97	
							TACOMA	USA WA	28.04.79						
112	F	33	14	28.04.79	05.02.87		TACOMA	USA	28.04.79	WG31	0115	SSP	59	97	93 M
							VIC. TX	USA WA	22.03.83						
113	U	33	14	28.04.79	28.04.79		TACOMA	USA	28.04.79		0110	SSP	59	97	0 D
							TACOMA	USA WA	28.04.79						
114	U	33	14	28.04.79	28.04.79		TACOMA	USA	28.04.79		0111	SSP	59	97	0 D
							TACOMA	USA WA	28.04.79						
115	U	33	14	28.04.79	03.05.79		TACOMA	USA	28.04.79		0112	SSP	59	97	5 D
							TACOMA	USA WA	28.04.79						
116	U	33	14	28.04.79	03.05.79		TACOMA	USA	28.04.79		0113	SSP	59	97	5 D
							TACOMA	USA WA	28.04.79						
117	M	39	54	01.05.79	04.05.79		TACOMA	USA	01.05.79		0116	SSP	47	24	3 D
							TACOMA	USA WA	01.05.79						
118	M	39	54	01.05.79	15.11.81		TACOMA	USA	01.05.79	WG32	0117	SSP	47	24	30 M
							TACOMA	USA WA	01.05.79						
119	M	39	54	01.05.79	16.08.79		TACOMA	USA	01.05.79	WG33	0118	SSP	47	24	4 M
							TACOMA	USA WA	01.05.79						
120	F	39	54	01.05.79	08.08.79		TACOMA	USA	01.05.79	WG34	0119	SSP	47	24	3 M
							TACOMA	USA WA	01.05.79						
121	M	17	29	02.05.79	07.09.79		TACOMA	USA	02.05.79	WG35	0121	SSP	83	73	4 M
							TACOMA	USA WA	02.05.79						
122	F	17	29	02.05.79	08.05.79		TACOMA	USA	02.05.79		0120	SSP	83	73	6 D
							TACOMA	USA WA	02.05.79						
123	F	17	29	02.05.79	25.01.85		TACOMA	USA	02.05.79	WG36	0122	SSP	83	73	69 M
							TACOMA	USA WA	02.05.79						
124.	U	17	29	02.05.79	05.05.79		TACOMA	USA	02.05.79		0244	SSP	83	73	3 D
							TACOMA	USA WA	02.05.79						
125	U	8	15	08.05.79	10.05.79		TACOMA	USA	08.05.79		0102	SSP	95	97	2 D
							TACOMA	USA WA	08.05.79						
126	U	8	15	08.05.79	10.05.79		TACOMA	USA	08.05.79		0103	SSP	95	97	2 D
							TACOMA	USA WA	08.05.79						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
127	M	6	12	11.05.79	27.09.79		TACOMA	USA	11.05.79	WG26	0106	SSP	107	97	5 M
							TACOMA	USA NA	11.05.79						
128	M	6	12	11.05.79	04.11.80		TACOMA	USA	11.05.79	WG27	0107	SSP	107	97	18 M
							TACOMA	USA NA	11.05.79						
129	M	6	12	11.05.79	20.01.83		TACOMA	USA	11.05.79	WG28	0108	SSP	107	97	44 M
							TACOMA	USA NA	11.05.79						
130	F	6	12	11.05.79	18.05.79		TACOMA	USA	11.05.79		0104	SSP	107	97	7 D
							TACOMA	USA NA	11.05.79						
131	F	6	12	11.05.79	03.08.79		TACOMA	USA	11.05.79		0105	SSP	107	97	3 M
							TACOMA	USA NA	11.05.79						
132	F	6	12	11.05.79	. .		TACOMA	USA	11.05.79	WG29	0109	SSP	107	97	
							TACOMA	USA NA	09.01.91						
133	M	24	30	11.05.79	10.07.79		TACOMA	USA	11.05.79		0124	SSP	71	73	2 M
							TACOMA	USA NA	11.05.79						
134	M	24	30	11.05.79	30.07.79		TACOMA	USA	11.05.79		0125	SSP	71	73	3 M
							TACOMA	USA NA	11.05.79						
135	M	24	30	11.05.79	07.01.90		TACOMA	USA	11.05.79	WG37	0126	SSP	71	73	128 M
							TACOMA	USA NA	29.11.88						
136	U	24	30	11.05.79	14.05.79		TACOMA	USA	11.05.79		0123	SSP	71	73	3 D
							TACOMA	USA NA	11.05.79						
137	M	17	132	20.04.80	09.09.84		TACOMA	USA	20.04.80	WG39	0129	SSP	95	11	53 M
							VIC. TX	USA NA	22.03.83						
138	F	17	132	20.04.80	07.04.89		TACOMA	USA	20.04.80	WG38	0128	SSP	95	11	108 M
							TACOMA	USA NA	20.04.80						
139	M	11	54	27.04.80	04.12.83		TACOMA	USA	27.04.80	WG53	0152	SSP	107	35	43 M
							TACOMA	USA NA	27.04.80						
140	M	11	54	27.04.80	15.06.88		TACOMA	USA	27.04.80	WG54	0153	SSP	107	35	98 M
							N. CAROLINA	USA NA	12.11.86						
141	M	11	54	27.04.80	19.06.81		TACOMA	USA	27.04.80	WG55	0154	SSP	107	35	14 M
							TACOMA	USA NA	27.04.80						
142	F	11	54	27.04.80	13.02.91		TACOMA	USA	27.04.80	WG56	0155	SSP	107	35	130 M
							FOSSIL RIM	USA NA	07.02.89						
143	F	11	54	27.04.80	. .		TACOMA	USA	27.04.80	WG57	0156	SSP	107	35	
							LOS ANGELES	USA NA	12.02.89						
144	M	42	79	03.05.80	04.02.85		TACOMA	USA	03.05.80	WG62	0163	SSP	47	24	57 M
							TACOMA	USA NA	03.05.80						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
145	M	42	79	03.05.80	08.02.83		TACOMA	USA	03.05.80	WG63	0164	SSP	47	24	33 M
							TACOMA	USA WA	03.05.80						
146	M	42	79	03.05.80	19.04.88		TACOMA	USA	03.05.80	WG64	0165	SSP	47	24	96 M
							TACOMA	USA WA	22.01.87						
147	M	42	79	03.05.80	04.08.81		TACOMA	USA	03.05.80	WG65	0166	SSP	47	24	15 M
							TACOMA	USA WA	03.05.80						
148	M	42	79	03.05.80	05.05.80		TACOMA	USA	03.05.80		0167	SSP	47	24	2 D
							TACOMA	USA WA	03.05.80						
149	F	42	79	03.05.80	05.05.80		TACOMA	USA	03.05.80		0168	SSP	47	24	2 D
							TACOMA	USA WA	03.05.80						
150	M	53	14	05.05.80	07.05.80		TACOMA	USA	05.05.80		0150	SSP	34	109	2 D
							TACOMA	USA WA	05.05.80						
151	M	53	14	05.05.80	10.05.80		TACOMA	USA	05.05.80		0151	SSP	34	109	5 D
							TACOMA	USA WA	05.05.80						
152	F	53	14	05.05.80	26.01.84		TACOMA	USA	05.05.80	WG49	0144	SSP	34	109	45 L
							TACOMA	USA WA	05.05.80						
153	F	53	14	05.05.80	28.02.82		TACOMA	USA	05.05.80	WG50	0145	SSP	34	109	22 M
							TACOMA	USA WA	05.05.80						
154	F	53	14	05.05.80	26.07.80		TACOMA	USA	05.05.80	WG51	0146	SSP	34	109	3 M
							TACOMA	USA WA	05.05.80						
155	F	53	14	05.05.80	. .		TACOMA	USA	05.05.80	WG52	0147	SSP	34	109	
							TACOMA	USA WA	05.05.80						
156	F	53	14	05.05.80	16.05.80		TACOMA	USA	05.05.80		0148	SSP	34	109	11 D
							TACOMA	USA WA	05.05.80						
157	F	53	14	05.05.80	26.06.80		TACOMA	USA	05.05.80		0149	SSP	34	109	2 M
							TACOMA	USA WA	05.05.80						
158	M	24	35	05.05.80	04.08.81		TACOMA	USA	05.05.80	WG58	0157	SSP	83	73	15 M
							TACOMA	USA WA	05.05.80						
159	M	24	35	05.05.80	26.01.84		TACOMA	USA	05.05.80	WG59	0158	SSP	83	73	45 M
							TACOMA	USA WA	05.05.80						
160	M	24	35	05.05.80	08.05.80		TACOMA	USA	05.05.80		0162	SSP	83	73	3 D
							TACOMA	USA WA	05.05.80						
161	F	24	35	05.05.80	28.10.80		TACOMA	USA	05.05.80	WG60	0159	SSP	83	73	6 M
							TACOMA	USA WA	05.05.80						
162	F	24	35	05.05.80	29.04.81		TACOMA	USA	05.05.80	WG61	0160	SSP	83	73	12 M
							TACOMA	USA WA	05.05.80						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
163	F	24	35	05.05.80	08.05.80		TACOMA	USA	05.05.80		0161	SSP	83	73	3 D
							TACOMA	USA NA	05.05.80						
164	M	6	13	10.05.80	02.10.86		TACOMA	USA	10.05.80	WG47	0137	SSP	119	109	77 M
							TACOMA	USA NA	10.05.80						
165	M	6	13	10.05.80	. .		TACOMA	USA	10.05.80	WG48	0138	SSP	119	109	
							TACOMA	USA NA	10.05.80						
166	M	6	13	10.05.80	14.06.80		TACOMA	USA	10.05.80		0142	SSP	119	109	1 M
							TACOMA	USA NA	10.05.80						
167	M	6	13	10.05.80	18.06.80		TACOMA	USA	10.05.80		0143	SSP	119	109	1 M
							TACOMA	USA NA	10.05.80						
168	F	6	13	10.05.80	03.08.81		TACOMA	USA	10.05.80	WG46	0136	SSP	119	109	15 M
							TACOMA	USA NA	10.05.80						
169	F	6	13	10.05.80	13.05.80		TACOMA	USA	10.05.80		0139	SSP	119	109	3 D
							TACOMA	USA NA	10.05.80						
170	F	6	13	10.05.80	05.06.80		TACOMA	USA	10.05.80		0140	SSP	119	109	25 D
							TACOMA	USA NA	10.05.80						
171	F	6	13	10.05.80	10.06.80		TACOMA	USA	10.05.80		0141	SSP	119	109	1 M
							TACOMA	USA NA	10.05.80						
172	M	8	15	12.05.80	03.08.81		TACOMA	USA	12.05.80	WG43	0133	SSP	107	109	15 M
							TACOMA	USA NA	12.05.80						
173	M	8	15	12.05.80	04.08.81		TACOMA	USA	12.05.80	WG44	0134	SSP	107	109	15 M
							TACOMA	USA NA	12.05.80						
174	M	8	15	12.05.80	04.08.81		TACOMA	USA	12.05.80	WG45	0135	SSP	107	109	15 M
							TACOMA	USA NA	12.05.80						
175	F	8	15	12.05.80	03.08.81		TACOMA	USA	12.05.80	WG40	0130	SSP	107	109	15 M
							TACOMA	USA NA	12.05.80						
176	F	8	15	12.05.80	03.08.81		TACOMA	USA	12.05.80	WG41	0131	SSP	107	109	15 M
							TACOMA	USA NA	12.05.80						
177	F	8	15	12.05.80	25.07.80		TACOMA	USA	12.05.80	WG42	0132	SSP	107	109	2 M
							TACOMA	USA NA	12.05.80						
178	M	24	152	23.04.81	25.04.81		TACOMA	USA	23.04.81		0188	SSP	95	12	2 D
							TACOMA	USA NA	23.04.81						
179	M	24	152	23.04.81	. .		TACOMA	USA	23.04.81	WG74	0189	SSP	95	12	
							BATON ROUGE	USA NA	01.02.90						
180	M	24	152	23.04.81	. .		TACOMA	USA	23.04.81	WG75	0190	SSP	95	12	
							FOSSIL RIM	USA NA	07.02.89						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
181	F	24	152	23.04.81	15.02.82		TACOMA	USA	23.04.81	WG76	0191	SSP	95	12	10 M
							TACOMA	USA WA	23.04.81						
182	F	24	152	23.04.81	23.04.81		TACOMA	USA	23.04.81		0192	SSP	95	12	0 D
							TACOMA	USA WA	23.04.81						
183	F	24	152	23.04.81	28.06.81		TACOMA	USA	23.04.81		0193	SSP	95	12	2 M
							TACOMA	USA WA	23.04.81						
184	M	34	132	01.05.81	29.05.88		TACOMA	USA	01.05.81	WG66	0169	SSP	83	24	85 M
							N. CAROLINA	USA WA	12.11.86						
185	F	34	132	01.05.81	23.01.82		TACOMA	USA	01.05.81	WG67	0170	SSP	83	24	9 M
							TACOMA	USA WA	01.05.81						
186	F	34	132	01.05.81	01.05.81		TACOMA	USA	01.05.81		0171	SSP	83	24	0 D
							TACOMA	USA WA	01.05.81						
187	M	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0174	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
188	M	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0175	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
189	M	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0176	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
190	F	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0177	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
191	F	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0178	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
192	F	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0179	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
193	F	8	13	01.05.81	01.05.81		TACOMA	USA	01.05.81		0180	SSP	119	121	0 D
							TACOMA	USA WA	01.05.81						
194	F	8	13	01.05.81	28.12.87		TACOMA	USA	01.05.81	WG69	0181	SSP	119	121	80 M
							N. CAROLINA	USA WA	12.11.86						
195	F	8	13	01.05.81	. .		TACOMA	USA	01.05.81	WG70	0182	SSP	119	121	
							TACOMA	USA WA	01.05.81						
196	F	26	54	01.05.81	25.05.88		TACOMA	USA	01.05.81	WG72	0186	SSP	47	48	85 M
							N. CAROLINA	USA WA	12.11.86						
197	F	26	54	01.05.81	25.08.81		TACOMA	USA	01.05.81	WG73	0187	SSP	47	48	4 M
							TACOMA	USA WA	01.05.81						
198	M	11	15	18.05.81	26.05.81		TACOMA	USA	18.05.81		0172	SSP	120	122	8 D
							TACOMA	USA WA	18.05.81						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location Location now		- arrived - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
199	F	11	15	18.05.81	06.09.81		TACOMA	USA	18.05.81	WG68	0173	SSP	120	122	4 M
							TACOMA	USA NA	18.05.81						
200	M	6	65	25.05.81	23.06.81		TACOMA	USA	25.05.81		0183	SSP	132	38	28 D
							TACOMA	USA NA	25.05.81						
201	F	6	65	25.05.81	25.05.81		TACOMA	USA	25.05.81		0184	SSP	132	38	0 D
							TACOMA	USA NA	25.05.81						
202	F	6	65	25.05.81	02.07.84		TACOMA	USA	25.05.81	WG71	0185	SSP	132	38	37 M
							TACOMA	USA NA	25.05.81						
203	M	11	54	23.04.82	01.11.82		WCSRC	USA	23.04.82	WG80	0208	SSP	131	59	6 M
							WCSRC	USA NA	23.04.82						
204	M	11	54	23.04.82	25.04.82		WCSRC	USA	23.04.82		0209	SSP	131	59	2 D
							WCSRC	USA NA	23.04.82						
205	F	11	54	23.04.82	. .		WCSRC	USA	23.04.82	WG77	0205	SSP	131	59	
							N. CAROLINA	USA NA	12.11.86						
206	F	11	54	23.04.82	04.08.87		WCSRC	USA	23.04.82	WG78	0206	SSP	131	59	63 M
							TACOMA	USA NA	23.07.87						
207	F	11	54	23.04.82	01.11.82		WCSRC	USA	23.04.82	WG79	0207	SSP	131	59	6 M
							WCSRC	USA NA	23.04.82						
208	M	52	132	29.04.82	30.07.89	.250	TACOMA	USA	29.04.82	WG83	0195	SSP	58	36	87 M
							N. CAROLINA	USA NA	11.01.89						
209	M	52	132	29.04.82	12.07.82	.250	TACOMA	USA	29.04.82		0196	SSP	58	36	2 M
							TACOMA	USA NA	29.04.82						
210	F	52	132	29.04.82	29.01.83	.250	TACOMA	USA	29.04.82	WG82	0194	SSP	58	36	9 M
							TACOMA	USA NA	29.04.82						
211	M	24	112	29.04.82	27.12.88		TACOMA	USA	29.04.82	WG84	0197	SSP	107	36	80 M
							N. CAROLINA	USA NA	12.11.86						
212	M	24	112	29.04.82	. .		TACOMA	USA	29.04.82	WG85	0198	SSP	107	36	
							TACOMA	USA NA	29.04.82						
213	M	24	112	29.04.82	27.09.88		TACOMA	USA	29.04.82	WG86	0199	SSP	107	36	77 M
							N. CAROLINA	USA NA	22.01.88						
214	F	24	112	29.04.82	07.07.82		TACOMA	USA	29.04.82		0200	SSP	107	36	2 M
							TACOMA	USA NA	29.04.82						
215	F	24	112	29.04.82	. .		TACOMA	USA	29.04.82	WG87	0201	SSP	107	36	
							TACOMA	USA NA	22.02.89						
216	F	24	112	29.04.82	21.08.88		TACOMA	USA	29.04.82	WG88	0202	SSP	107	36	76 M
							ALEX	USA NA	15.12.83						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
217	F	24	112	29.04.82	20.08.82		TACOMA	USA	29.04.82	WG89	0203	SSP	109	36	4 M
							TACOMA	USA NA	29.04.82						
218	F	24	112	29.04.82	03.09.85		TACOMA	USA	29.04.82	WG90	0204	SSP	107	36	40 M
							TACOMA	USA NA	29.04.82						
219	M	53	79	19.04.83	. .		AUDUBON	USA	19.04.83	LF106	0234	SSP	69	59	
							SMOKIES	USA NA	28.01.91						
220	F	53	79	19.04.83	30.08.83		AUDUBON	USA	19.04.83	LF107	0235	SSP	69	59	4 M
							AUDUBON	USA NA	19.04.83						
221	F	53	79	19.04.83	. .		AUDUBON	USA	19.04.83	LF108	0236	SSP	69	59	
							TACOMA	USA NA	20.11.84						
222	F	53	79	19.04.83	. .		AUDUBON	USA	19.04.83	LF109	0237	SSP	69	59	
							TACOMA	USA NA	07.12.88						
223	U	53	79	19.04.83	24.04.83		AUDUBON	USA	19.04.83	LF105	0233	SSP	69	59	5 D
							AUDUBON	USA NA	19.04.83						
224	M	11	54	23.04.83	. .		WCSRC	USA	23.04.83	WG92	0211	SSP	143	71	
							TACOMA	USA NA	05.12.89						
225	M	11	54	23.04.83	. .		WCSRC	USA	23.04.83	WG93	0212	SSP	143	71	
							TACOMA	USA NA	16.01.91						
226	U	11	54	23.04.83	28.04.83		WCSRC	USA	23.04.83	WG91	0210	SSP	143	71	5 D
							WCSRC	USA NA	23.04.83						
227	M	164	196	23.04.83	03.09.89	.063	TACOMA	USA	23.04.83	WG94	0213	SSP	33	24	76 M
							N. CAROLINA	USA NA	12.11.86						
228	M	164	196	23.04.83	01.05.83	.063	TACOMA	USA	23.04.83		0214	SSP	33	24	8 D
							TACOMA	USA NA	23.04.83						
229	F	164	196	23.04.83	02.05.83	.063	TACOMA	USA	23.04.83		0215	SSP	33	24	9 D
							TACOMA	USA NA	23.04.83						
230	F	146	152	08.05.83	15.10.88		TACOMA	USA	08.05.83	WG95	0216	SSP	34	36	65 M
							VIC. TX	USA NA	10.02.87						
231	F	146	152	08.05.83	18.12.87		TACOMA	USA	08.08.83	WG96	0217	SSP	34	36	55 M
							N. CAROLINA	USA NA	12.11.86						
232	F	146	152	08.05.83	10.03.84		TACOMA	USA	08.05.83	WG97	0218	SSP	34	36	10 M
							TACOMA	USA NA	08.05.83						
233	F	146	152	08.05.83	11.01.91		TACOMA	USA	08.05.83	WG98	0219	SSP	34	36	92 M
							VIC. TX	USA NA	08.01.91						
234	M	140	35	10.05.83	28.11.84		TACOMA	USA	10.05.83	WG99	0220	SSP	34	109	19 M
							TACOMA	USA NA	10.05.83						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
235	M	140	35	10.05.83	23.05.83		TACOMA	USA	10.05.83		0221	SSP	34	109	13 D
							TACOMA	USA NA	10.05.83						
236	M	140	35	10.05.83	23.05.83		TACOMA	USA	10.05.83		0222	SSP	34	109	13 D
							TACOMA	USA NA	10.05.83						
237	M	140	35	10.05.83	10.06.83		TACOMA	USA	10.05.83		0223	SSP	34	109	1 M
							TACOMA	USA NA	10.05.83						
238	F	140	35	10.05.83	24.07.84		TACOMA	USA	10.05.83	WG100	0224	SSP	34	109	14 M
							TACOMA	USA NA	10.05.83						
239	F	140	35	10.05.83	16.05.83		TACOMA	USA	10.05.83		0225	SSP	34	109	6 D
							TACOMA	USA NA	10.05.83						
240	F	140	35	10.05.83	31.05.83		TACOMA	USA	10.05.83		0226	SSP	34	109	21 D
							TACOMA	USA NA	10.05.83						
241	F	140	35	10.05.83	23.06.83		TACOMA	USA	10.05.83		0227	SSP	34	109	1 M
							TACOMA	USA NA	10.05.83						
242	M	52	195	13.05.83	04.11.89		TACOMA	USA	13.05.83	WG104	0232	SSP	70	24	78 M
							S. CAROLINA	USA NA	19.11.87						
243	F	52	195	13.05.83	. .		TACOMA	USA	13.05.83	WG101	0228	SSP	70	24	
							TALLAHASSE	USA NA	15.01.91						
244	F	52	195	13.05.83	14.07.86		TACOMA	USA	13.05.83	WG102	0229	SSP	70	24	38 M
							G.B. FL	USA NA	25.04.84						
245	F	52	195	13.05.83	27.09.89		TACOMA	USA	13.05.83	WG103	0230	SSP	70	24	76 M
							MISSISSIPPI	USA NA	10.01.89						
246	F	52	195	13.05.83	14.05.83		TACOMA	USA	13.05.83		0231	SSP	70	24	1 D
							TACOMA	USA NA	13.05.83						
247	M	11	54	19.04.84	. .		WCSRC	USA	19.04.84	LM110	0247	SSP	155	83	
							TACOMA	USA NA	21.07.89						
248	F	11	54	19.04.84	. .		WCSRC	USA	19.04.84	LM111	0248	SSP	155	83	
							KNOXVILLE	USA NA	17.01.91						
249	M	11	54	19.04.84	28.04.84		WCSRC	USA	19.04.84		0249	SSP	155	83	9 D
							WCSRC	USA NA	19.04.84						
250	F	11	54	19.04.84	28.04.84		WCSRC	USA	19.04.84		0250	SSP	155	83	9 D
							WCSRC	USA NA	19.04.84						
251	F	146	216	21.04.84	. .		ALEX	USA	21.04.84	GL112	0251	SSP	46	24	
							TACOMA	USA NA	15.01.91						
252	F	146	216	21.04.84	09.05.90		ALEX	USA	21.04.84	GL113	0252	SSP	46	24	73 M
							FOSSIL RIM	USA NA	07.02.89						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
253	F	146	216	21.04.84	. .		ALEX	USA	21.04.84	GL114	0253	SSP	46	24	
							TACOMA	USA NA	13.12.90						
254	F	146	216	21.04.84	08.01.89		ALEX	USA	21.04.84	GL115	0254	SSP	46	24	57 M
							ALEX	USA NA	21.04.84						
255	M	137	112	23.04.84	. .		VIC. TX	USA	23.04.84	UH116	0255	SSP	46	60	
							TACOMA	USA NA	08.11.85						
256	M	137	112	23.04.84	99.99.99		VIC. TX	USA	23.04.84	UH117	0256	SSP	46	60	?
							VIC. TX	USA NA	23.04.84						
257	M	137	112	23.04.84	26.06.84		VIC. TX	USA	23.04.84		0257	SSP	46	60	2 M
							VIC. TX	USA NA	23.04.84						
258	F	137	112	23.04.84	26.06.84		VIC. TX	USA	23.04.84		0258	SSP	46	60	2 M
							VIC. TX	USA NA	23.04.84						
259	F	137	112	23.04.84	26.06.84		VIC. TX	USA	23.04.84		0259	SSP	46	60	2 M
							VIC. TX	USA NA	23.04.84						
260	F	137	112	23.04.84	26.06.84		VIC. TX	USA	23.04.84		0260	SSP	46	60	2 M
							VIC. TX	USA NA	23.04.84						
261	M	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG118	0261	SSP	47	74	14 M
							TACOMA	USA NA	18.05.84						
262	M	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG119	0262	SPP	47	74	14 M
							TACOMA	USA NA	18.05.84						
263	M	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG120	0263	SSP	47	74	14 M
							TACOMA	USA NA	18.05.84						
264	F	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG121	0264	SSP	47	74	14 M
							TACOMA	USA NA	18.05.84						
265	F	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG122	0265	SSP	47	74	14 M
							TACOMA	USA NA	18.05.84						
266	F	144	65	18.05.84	24.07.85		TACOMA	USA	18.05.84	WG123	0266	SSP	47	74	14 M
							TACOMA	USA NA	18.05.84						
267	M	53	79	23.04.85	23.04.85		AUDUBON	USA	23.04.85		0267	SSP	93	84	0 D
							AUDUBON	USA NA	23.04.85						
268	M	53	79	23.04.85	. .		AUDUBON	USA	23.04.85	LF268	0268	SSP	93	84	
							TACOMA	USA NA	15.01.91						
269	F	53	79	23.04.85	. .		AUDUBON	USA	23.04.85	LF269	0269	SSP	93	84	
							TACOMA	USA NA	20.01.89						
270	F	53	79	23.04.85	. .		AUDUBON	USA	23.04.85	LF270	0270	SSP	93	84	
							AUDUBON	USA NA	23.04.85						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
271	F	53	79	23.04.85	23.04.85		AUDUBON	USA	23.04.85		0271	SSP	93	84	0 D
							AUDUBON	USA NA	23.04.85						
272	M	11	54	03.05.85	. .		WCSRC	USA	03.05.85	LM272	0272	SSP	167	96	
							TACOMA	USA NA	13.12.90						
273	M	11	54	03.05.85	08.05.85		WCSRC	USA	03.05.85		0273	SSP	167	96	5 D
							WCSRC	USA NA	03.05.85						
274	F	11	54	03.05.85	08.05.85		WCSRC	USA	03.05.85		0274	SSP	167	96	5 D
							WCSRC	USA NA	03.05.85						
275	F	11	54	03.05.85	08.05.85		WCSRC	USA	03.05.85		0275	SSP	167	96	5 D
							WCSRC	USA NA	03.05.85						
276	F	11	54	03.05.85	08.05.85		WCSRC	USA	03.05.85		0276	SSP	167	96	5 D
							WCSRC	USA NA	03.05.85						
277	F	34	132	06.05.85	. .		TACOMA	USA	06.05.85	WG277	0277	SSP	131	72	
							NATIONAL ZOO	USA NA	19.09.90						
278	F	34	132	06.05.85	. .		TACOMA	USA	06.05.85	WG278	0278	SSP	131	72	
							VIC. TX	USA NA	17.01.91						
279	F	34	132	06.05.85	29.07.88		TACOMA	USA	06.05.85	WG279	0279	SSP	131	72	39 M
							S. CAROLINA	USA NA	19.11.87						
280	M	213	244	07.05.85	. .		G.B. FL	USA	07.05.85	TZ280	0280	SSP	34	24	
							N. CAROLINA	USA NA	05.01.90						
281	M	213	244	07.05.85	14.07.86		G.B. FL	USA	07.05.85	TZ281	0281	SSP	34	24	14 M
							G.B. FL	USA NA	07.05.85						
282	M	213	244	07.05.85	. .		G.B. FL	USA	07.05.85	TZ282	0282	SSP	34	24	
							OGLEBAY	USA NA	28.12.88						
283	F	213	244	07.05.85	12.09.85		G.B. FL	USA	07.05.85		0283	SSP	34	24	4 M
							G.B. FL	USA NA	07.05.85						
284	M	11	54	21.04.86	15.08.86		WCSRC	USA	21.04.86	LM284	0284	SSP	179	107	4 M
							WCSRC	USA NA	21.04.86						
285	F	11	54	21.04.86	29.04.86		WCSRC	USA	21.04.86		0285	SSP	179	107	8 D
							WCSRC	USA NA	21.04.86						
286	F	11	54	21.04.86	07.05.86		WCSRC	USA	21.04.86		0286	SSP	179	107	16 D
							WCSRC	USA NA	21.04.86						
287	F	11	54	21.04.86	15.08.86		WCSRC	USA	21.04.86	LM287	0287	SSP	179	107	4 M
							WCSRC	USA NA	21.04.86						
288	F	11	54	21.04.86	27.10.86		WCSRC	USA	21.04.86	LM288	0288	SSP	179	107	6 M
							WCSRC	USA NA	21.04.86						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
289	F	213	244	28.04.86	19.08.89		G.B. FL	USA	28.04.86	TZ289	0289	SSP	46	36	40 M
							S. CAROLINA	USA NA	22.11.88						
290	F	213	244	28.04.86	11.12.86		G.B. FL	USA	28.04.86	TZ290	0290	SSP	46	36	7 M
							TACOMA	USA NA	25.09.86						
291	M	213	244	28.04.86	. .		G.B. FL	USA	28.04.86	TZ291	0291	SSP	46	36	
							LOS ANGELES	USA NA	20.12.90						
292	M	213	244	28.04.86	. .		G.B. FL	USA	28.04.86	TZ292	0292	SSP	46	36	
							LOS ANGELES	USA NA	12.02.89						
293	M	213	244	28.04.86	. .		G.B. FL	USA	28.04.86	TZ293	0293	SSP	46	36	
							VIC. TX	USA NA	30.11.88						
294	M	24	196	29.04.86	. .		TACOMA	USA	29.04.86	WG294	0294	SSP	155	60	
							TACOMA	USA NA	05.12.89						
295	M	24	196	29.04.86	02.10.86		TACOMA	USA	29.04.86	WG295	0295	SSP	155	60	5 M
							TACOMA	USA NA	29.04.86						
296	F	24	196	29.04.86	23.12.86		TACOMA	USA	29.04.86	WG296	0296	SSP	155	60	8 M
							TACOMA	USA NA	29.04.86						
297	F	24	196	29.04.86	. .		TACOMA	USA	29.04.86	WG297	0297	SSP	155	60	
							FRESNO ZOO	USA NA	07.01.91						
298	F	24	196	29.04.86	06.07.86		TACOMA	USA	29.04.86	WG298	0298	SSP	155	60	2 M
							TACOMA	USA NA	29.04.86						
299	M	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG299	0299	SSP	34	60	
							KNOXVILLE	USA NA	17.01.91						
300	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG300	0300	SSP	34	60	
							N. CAROLINA	USA NA	22.01.88						
301	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG301	0301	SSP	34	60	
							TACOMA	USA NA	19.12.89						
302	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG302	0302	SSP	34	60	
							FOSSIL RIM	USA NA	06.12.90						
303	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG303	0303	SSP	34	60	
							SMOKIES	USA NA	28.01.91						
304	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG304	0304	SSP	34	60	
							N. CAROLINA	USA NA	09.10.90						
305	F	227	194	06.05.86	. .	.063	TACOMA	USA	06.05.86	WG305	0305	SSP	34	60	
							WCSRC	USA NA	06.12.88						
306	F	227	194	06.05.86	14.07.86	.063	TACOMA	USA	06.05.86	WG306	0306	SSP	34	60	2 M
							TACOMA	USA NA	06.05.86						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
307	M	247	54	18.04.87	28.04.87	.250	WCSRC	USA	18.04.87		0307	SSP	34	119	10 D
							WCSRC	USA NA	18.04.87						
308	U	247	54	18.04.87	27.04.87	.250	WCSRC	USA	18.04.87		0308	SSP	34	119	9 D
							WCSRC	USA NA	18.04.87						
309	U	247	54	18.04.87	27.04.87	.250	WCSRC	USA	18.04.87		0309	SSP	34	119	9 D
							WCSRC	USA NA	18.04.87						
310	M	227	194	25.04.87	28.04.87	.063	N. CAROLINA	USA	25.04.87		0310	SSP	46	72	3 D
							N. CAROLINA	USA NA	25.04.87						
311	M	242	279	26.04.87	21.08.87	.063	TACOMA	USA	26.04.87	WG311	0311	SSP	45	24	4 M
							TACOMA	USA NA	26.04.87						
312	M	242	279	26.04.87	. .	.063	TACOMA	USA	26.04.87	WG312	0312	SSP	45	24	
							WCSRC	USA NA	25.01.91						
313	F	242	279	26.04.87	. .	.063	TACOMA	USA	26.04.87	WG313	0313	SSP	45	24	
							N. CAROLINA	USA NA	22.01.88						
14	F	242	279	26.04.87	08.02.88	.063	TACOMA	USA	26.04.87	WG314	0314	SSP	45	24	9 M
							TACOMA	USA NA	26.04.87						
315	F	242	279	26.04.87	. .	.063	TACOMA	USA	26.04.87	WG315	0315	SSP	45	24	
							BATON ROUGE	USA NA	06.12.88						
316	F	242	279	26.04.87	. .	.063	TACOMA	USA	26.04.87	WG316	0316	SSP	45	24	
							N. CAROLINA	USA NA	22.01.88						
317	M	52	142	26.04.87	11.08.87	.125	TACOMA	USA	26.04.87	WG317	0317	SSP	117	84	4 M
							TACOMA	USA NA	26.04.87						
318	M	52	142	26.04.87	11.08.87	.125	TACOMA	USA	26.04.87	WG318	0318	SSP	117	84	4 M
							TACOMA	USA NA	26.04.87						
319	M	52	142	26.04.87	. .	.125	TACOMA	USA	26.04.87	WG319	0319	SSP	117	84	
							N. CAROLINA	USA NA	22.01.88						
320	F	179	245	12.05.87	13.08.87	.031	TACOMA	USA	12.05.87	WG320	0320	SSP	71	48	3 M
							TACOMA	USA NA	12.05.87						
321	F	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG321	0321	SSP	71	48	
							TACOMA	USA NA	12.05.87						
322	F	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG322	0322	SSP	71	48	
							TACOMA	USA NA	13.12.90						
323	F	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG323	0323	SSP	71	48	
							LBL	USA NA	28.01.91						
324	F	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG324	0324	SSP	71	48	
							BEARDSLEY ZO	USA NA	28.01.91						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
325	F	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG325	0325	SSP	71	48	
							TACOMA	USA NA	12.05.87						
326	F	179	245	12.05.87	16.08.87	.031	TACOMA	USA	12.05.87	WG326	0326	SSP	71	48	3 M
							TACOMA	USA NA	12.05.87						
327	M	179	245	12.05.87	20.09.90	.031	TACOMA	USA	12.05.87	WG327	0327	SSP	71	48	40 M
							DURANT IS.	USA NA	12.07.90						
328	M	179	245	12.05.87	. .	.031	TACOMA	USA	12.05.87	WG328	0328	SSP	71	48	
							N. CAROLINA	USA NA	22.01.88						
329	M	242	279	21.04.88	25.04.88	.063	S. CAROLINA	USA	21.04.88	FWS329	0329	SSP	59	36	4 D
							S. CAROLINA	USA NA	21.04.88						
330	F	242	279	21.04.88	14.06.88	.063	S. CAROLINA	USA	21.04.88	FWS330	0330	SSP	59	36	2 M
							S. CAROLINA	USA NA	21.04.88						
331	M	242	279	21.04.88	. .	.063	S. CAROLINA	USA	21.04.88	FWS331	0331	SSP	59	36	
							N. CAROLINA	USA NA	18.01.89						
332	M	242	279	21.04.88	22.11.89	.063	S. CAROLINA	USA	21.04.88	FWS332	0332	SSP	59	36	19 M
							N. CAROLINA	USA NA	18.01.89						
333	M	213	245	05.05.88	10.05.88		N. CAROLINA	USA	05.05.88	FWS333	0333	SSP	72	60	5 D
							N. CAROLINA	USA NA	05.05.88						
334	M	213	245	05.05.88	25.05.88		N. CAROLINA	USA	05.05.88	FWS334	0334	SSP	72	60	20 D
							N. CAROLINA	USA NA	05.05.88						
335	M	213	245	05.05.88	. .		N. CAROLINA	USA	05.05.88	FWS335	0335	SSP	72	60	
							NATIONAL ZOO	USA NA	19.09.90						
336	M	213	245	05.05.88	. .		N. CAROLINA	USA	05.05.88	FWS336	0336	SSP	72	60	
							TACOMA	USA NA	23.08.90						
337	F	213	245	05.05.88	. .		N. CAROLINA	USA	05.05.88	FWS337	0337	SSP	72	60	
							N. CAROLINA	USA NA	05.05.88						
338	F	213	245	05.05.88	. .		N. CAROLINA	USA	05.05.88	FWS338	0338	SSP	72	60	
							ALEX	USA NA	12.12.90						
339	F	213	245	05.05.88	27.11.90		N. CAROLINA	USA	05.05.88	FWS339	0339	SSP	72	60	31 M
							TACOMA	USA NA	08.12.88						
340	M	268	215	18.05.88	26.07.88		BURNET	USA	18.05.88	LV340	0340	SSP	37	73	2 M
							BURNET	USA NA	18.05.88						
341	M	268	215	18.05.88	. .		BURNET	USA	18.05.88	LV341	0341	SSP	37	73	
							SMOKIES	USA NA	15.01.91						
342	F	268	215	18.05.88	. .		BURNET	USA	18.05.88	LV342	0342	SSP	37	73	
							LOWRY PK ZOO	USA NA	05.12.90						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
343	F	268	215	18.05.88	29.07.88		BURNET	USA	18.05.88	LV343	0343	SSP	37	73	2 M
							BURNET	USA NA	18.05.88						
344	F	211	196	05.05.88	. .		N. CAROLINA	USA	05.05.88	FWS344	0344	SSP	72	84	
							N. CAROLINA	USA NA	05.05.88						
345	M	291	289	10.05.88	03.07.88	.250	TACOMA	USA	10.05.88	WG345	0345	SSP	22	24	2 M
							TACOMA	USA NA	10.05.88						
346	M	291	289	10.05.88	10.10.89	.250	TACOMA	USA	10.05.88	WG346	0346	SSP	22	24	17 M
							TACOMA	USA NA	10.05.88						
347	F	280	269	03.05.88	. .	.047	AUDUBON	USA	03.05.88	LF347	0347	SSP	34	36	
							TACOMA	USA NA	20.01.89						
348	F	280	269	03.05.88	. .	.047	AUDUBON	USA	03.05.88	LF348	0348	SSP	34	36	
							ROGER WILLIA	USA NA	07.01.91						
349	M	280	269	03.05.88	. .	.047	AUDUBON	USA	03.05.88	LF349	0349	SSP	34	36	
							LBL	USA NA	30.01.91						
350	M	280	269	03.05.88	. .	.047	AUDUBON	USA	03.05.88	LF350	0350	SSP	34	36	
							FRESNO ZOO	USA NA	18.09.89						
351	F	184	205	28.04.88	27.01.91	.063	N. CAROLINA	USA	28.04.88	FWS351	0351	SSP	82	72	33 M
							N. CAROLINA	USA NA	28.04.88						
352	M	219	303	15.04.89	. .	.063	TALLAHASSE	USA	15.04.89	352	0352	SSP	70	35	
							N. CAROLINA	USA NA	06.12.90						
353	M	219	303	15.04.89	. .	.063	TALLAHASSE	USA	15.04.89	353	0353	SSP	70	35	
							ROSS PARK	USA NA	05.09.90						
354	M	219	303	15.04.89	. .	.063	TALLAHASSE	USA	15.04.89	354	0354	SSP	70	35	
							TALLAHASSE	USA NA	15.04.89						
355	M	293	301	29.04.89	29.04.89	.055	VIC. TX	USA	29.04.89	UH355	0355	SSP	34	36	0 D
							VIC. TX	USA NA	29.04.89						
356	M	293	301	29.04.89	. .	.055	VIC. TX	USA	29.04.89	UH356	0356	SSP	34	36	
							AUDUBON	USA NA	19.12.89						
357	M	293	301	29.04.89	. .	.055	VIC. TX	USA	29.04.89	UH357	0357	SSP	34	36	
							TACOMA	USA NA	19.12.89						
358	M	293	301	29.04.89	. .	.055	VIC. TX	USA	29.04.89	UH358	0358	SSP	34	36	
							MISSISSIPPI	USA NA	16.01.91						
359	M	293	301	29.04.89	. .	.055	VIC. TX	USA	29.04.89	UH359	0359	SSP	34	36	
							LOWRY PK ZOO	USA NA	03.01.90						
360	F	293	301	29.04.89	. .	.055	VIC. TX	USA	29.04.89	UH360	0360	SSP	34	36	
							TACOMA	USA NA	19.12.89						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
361	F	293	301	29.04.89	22.11.90	.055	VIC. TX	USA	29.04.89	UH361	0361	SSP	34	36	19 M
							LOWRY PK ZOO	USA NA	03.01.90						
362	M	268	277	02.05.89	04.08.89	.063	BURNET	USA	02.05.89	LV362	0362	SSP	46	48	3 M
							BURNET	USA NA	02.05.89						
363	F	268	277	02.05.89	. .	.063	BURNET	USA	02.05.89	LV363	0363	SSP	46	48	
							OGLEBAY	USA NA	12.12.90						
364	F	268	277	02.05.89	. .	.063	BURNET	USA	02.05.89	LV364	0364	SSP	46	48	
							BURNET	USA NA	02.05.89						
365	F	268	277	02.05.89	03.05.89	.063	BURNET	USA	02.05.89	LV365	0365	SSP	46	48	1 D
							BURNET	USA NA	02.05.89						
366	F	327	304	03.05.89	03.05.89	.063	ROSS PARK	USA	03.05.89	NW366	0366	SSP	22	36	0 D
							ROSS PARK	USA NA	03.05.89						
367	M	291	233	03.05.89	06.05.89	.039	FOSSIL RIM	USA	03.05.89	YK367	0367	SSP	34	72	3 D
							FOSSIL RIM	USA NA	03.05.89						
368	M	291	233	03.05.89	. .	.039	FOSSIL RIM	USA	03.05.89	YK368	0368	SSP	34	72	
							TACOMA	USA NA	11.12.90						
369	M	291	233	03.05.89	. .	.039	FOSSIL RIM	USA	03.05.89	YK369	0369	SSP	34	72	
							BIRMINGHAM	USA NA	11.12.90						
370	F	291	233	03.05.89	08.05.89	.039	FOSSIL RIM	USA	03.05.89	YK370	0370	SSP	34	72	5 D
							FOSSIL RIM	USA NA	03.05.89						
371	F	291	233	03.05.89	. .	.039	FOSSIL RIM	USA	03.05.89	YK371	0371	SSP	34	72	
							TACOMA	USA NA	13.12.89						
372	M	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS372	0372	SSP	46	72	
							MISSISSIPPI	USA NA	06.05.89						
373	M	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS373	0373	SSP	46	72	
							N. CAROLINA	USA NA	09.11.90						
374	M	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS374	0374	SSP	46	72	
							N. CAROLINA	USA NA	05.01.90						
375	M	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS375	0375	SSP	46	72	
							S. CAROLINA	USA NA	15.01.90						
376	F	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS376	0376	SSP	46	72	
							MISSISSIPPI	USA NA	06.05.89						
377	F	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS377	0377	SSP	46	72	
							MISSISSIPPI	USA NA	06.05.89						
378	F	280	245	06.05.89	. .	.125	MISSISSIPPI	USA	06.05.89	USPS378	0378	SSP	46	72	
							SMOKIES	USA NA	15.01.91						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # / Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
379	F	242	289	14.05.89	. .	.125	S. CAROLINA	USA	14.05.89	FWS379	0379	SSP	70	37	
							S. CAROLINA	USA NA	14.05.89						
380	F	242	289	14.05.89	. .	.125	S. CAROLINA	USA	14.05.89	FWS380	0380	SSP	70	37	
							N. CAROLINA	USA NA	17.04.90						
381	F	242	289	14.05.89	31.08.89	.125	S. CAROLINA	USA	14.05.89	FWS381	0381	SSP	70	37	4 M
							S. CAROLINA	USA NA	14.05.89						
382	F	242	289	14.05.89	. .	.125	S. CAROLINA	USA	14.05.89	FWS382	0382	SSP	70	37	
							N. CAROLINA	USA NA	17.04.90						
383	F	242	289	14.05.89	. .	.125	S. CAROLINA	USA	14.05.89	FWS383	0383	SSP	70	37	
							N. CAROLINA	USA NA	16.01.90						
384	M	212	195	21.05.89	23.05.89		TACOMA	USA	21.05.89	WG384	0384	SSP	83	97	2 D
							TACOMA	USA NA	21.05.89						
385	M	212	195	21.05.89	24.05.89		TACOMA	USA	21.05.89	WG385	0385	SSP	83	97	3 D
							TACOMA	USA NA	21.05.89						
386	M	212	195	21.05.89	. .		TACOMA	USA	21.05.89	WG386	0386	SSP	83	97	
							ROGER WILLIA	USA NA	07.01.91						
387	M	212	195	21.05.89	. .		TACOMA	USA	21.05.89	WG387	0387	SSP	83	97	
							BURNET	USA NA	04.12.90						
388	F	212	195	21.05.89	. .		TACOMA	USA	21.05.89	WG388	0388	SSP	83	97	
							ROSS PARK	USA NA	05.09.90						
389	F	212	195	21.05.89	05.12.89		TACOMA	USA	21.05.89	WG389	0389	SSP	83	97	6 M
							TACOMA	USA NA	21.05.89						
390	F	212	195	21.05.89	. .		TACOMA	USA	21.05.89	WG390	0390	SSP	83	97	
							BIRMINGHAM	USA NA	04.12.90						
391	F	212	195	21.05.89	. .		TACOMA	USA	21.05.89	WG391	0391	SSP	83	97	
							TACOMA	USA NA	21.05.89						
392	M	227	205	27.04.89	. .	.094	N. CAROLINA	USA	27.04.89	FWS392	0392	SSP	70	84	
							N. CAROLINA	USA NA	27.04.89						
393	F	227	205	27.04.89	24.01.90	.094	N. CAROLINA	USA	27.04.89	FWS393	0393	SSP	70	84	9 M
							N. CAROLINA	USA NA	27.04.89						
394	F	227	205	27.04.89	. .	.094	N. CAROLINA	USA	27.04.89	FWS394	0394	SSP	70	84	
							N. CAROLINA	USA NA	27.04.89						
395	F	227	205	27.04.89	11.01.90	.094	N. CAROLINA	USA	27.04.89	FWS395	0395	SSP	70	84	8 M
							N. CAROLINA	USA NA	27.04.89						
396	M	327	304	09.04.90	11.04.90	.063	ROSS PARK	USA	09.04.90	RW396	0396	SSP	33	47	2 D
							ROSS PARK	USA NA	09.04.90						

RED WOLF (Canis rufus gregoryi)
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Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
397	M	327	304	09.04.90	12.10.90	.063	ROSS PARK	USA	09.04.90	NW397	0397	SSP	33	47	6 M
							DURANT IS.	USA NA	12.07.90						
398	F	327	304	09.04.90	15.10.90	.063	ROSS PARK	USA	09.04.90	NW398	0398	SSP	33	47	6 M
							DURANT IS.	USA NA	12.07.90						
399	F	327	304	09.04.90	12.10.90	.063	ROSS PARK	USA	09.04.90	NW399	0399	SSP	33	47	6 M
							DURANT IS.	USA NA	12.07.90						
400	F	327	304	09.04.90	07.08.90	.063	ROSS PARK	USA	09.04.90	NW400	0400	SSP	33	47	4 M
							DURANT IS.	USA NA	12.07.90						
401	U	327	304	09.04.90	03.05.90	.063	ROSS PARK	USA	09.04.90	NW401	0401	SSP	33	47	24 D
							ROSS PARK	USA NA	09.04.90						
402	U	327	304	09.04.90	03.05.90	.063	ROSS PARK	USA	09.04.90	NW402	0402	SSP	33	47	24 D
							ROSS PARK	USA NA	09.04.90						
403	M	293	248	10.04.90	11.04.90	.031	VIC. TX	USA	10.04.90	UH403	0403	SSP	45	72	1 D
							VIC. TX	USA NA	10.04.90						
404	M	293	248	10.04.90	12.04.90	.031	VIC. TX	USA	10.04.90	UH404	0404	SSP	45	72	2 D
							VIC. TX	USA NA	10.04.90						
405	M	293	248	10.04.90	. .	.031	VIC. TX	USA	10.04.90	UH405	0405	SSP	45	72	
							BEARDSLEY ZO	USA NA	13.12.90						
406	M	293	248	10.04.90	. .	.031	VIC. TX	USA	10.04.90	UH406	0406	SSP	45	72	
							ALEX	USA NA	19.12.90						
407	F	293	248	10.04.90	19.04.90	.031	VIC. TX	USA	10.04.90	UH407	0407	SSP	45	72	9 D
							VIC. TX	USA NA	10.04.90						
408	F	293	248	10.04.90	. .	.031	VIC. TX	USA	10.04.90	UH408	0408	SSP	45	72	
							FOSSIL RIM	USA NA	08.01.91						
409	F	293	248	10.04.90	. .	.031	VIC. TX	USA	10.04.90	UH409	0409	SSP	45	72	
							FOSSIL RIM	USA NA	08.01.91						
410	M	219	303	23.04.90	. .	.063	ST. VINCENT	USA	23.04.90	410	0410	SSP	82	48	
							ST. VINCENT	USA NA	23.04.90						
411	M	219	303	23.04.90	. .	.063	ST. VINCENT	USA	23.04.90	411	0411	SSP	82	48	
							N. CAROLINA	USA NA	06.12.90						
412	M	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG412	0412	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
413	M	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG413	0413	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
414	M	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG414	0414	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						

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415	M	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG415	0415	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
416	M	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG416	0416	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
417	F	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG417	0417	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
418	F	335	277	29.04.90	30.04.90	.031	TACOMA	USA	29.04.90	WG418	0418	SSP	22	60	1 D
							TACOMA	USA NA	29.04.90						
419	F	335	277	29.04.90	. .	.031	TACOMA	USA	29.04.90	WG419	0419	SSP	22	60	
							TACOMA	USA NA	29.04.90						
420	F	335	277	29.04.90	. .	.031	TACOMA	USA	29.04.90	WG420	0420	SSP	22	60	
							TACOMA	USA NA	29.04.90						
421	M	282	278	01.05.90	. .	.031	OGLEBAY	USA	01.05.90	WJ421	0421	SSP	58	60	
							TACOMA	USA NA	13.12.90						
422	F	282	278	01.05.90	01.05.90	.031	OGLEBAY	USA	01.05.90	WJ422	0422	SSP	58	60	0 D
							OGLEBAY	USA NA	01.05.90						
423	F	282	278	01.05.90	03.05.90	.031	OGLEBAY	USA	01.05.90	WJ423	0423	SSP	58	60	2 D
							OGLEBAY	USA NA	01.05.90						
424	F	282	278	01.05.90	15.01.91	.031	OGLEBAY	USA	01.05.90	WJ424	0424	SSP	58	60	8 M
							OGLEBAY	USA NA	01.05.90						
425	F	282	278	01.05.90	. .	.031	OGLEBAY	USA	01.05.90	WJ425	0425	SSP	58	60	
							OGLEBAY	USA NA	01.05.90						
426	M	328	313	02.05.90	. .	.094	N. CAROLINA	USA	02.05.90	FWS426	0426	SSP	34	36	
							N. CAROLINA	USA NA	02.05.90						
427	M	328	313	02.05.90	20.10.90	.094	N. CAROLINA	USA	02.05.90	FWS427	0427	SSP	34	36	6 M
							N. CAROLINA	USA NA	02.05.90						
428	M	328	313	02.05.90	. .	.094	N. CAROLINA	USA	02.05.90	FWS428	0428	SSP	34	36	
							TACOMA	USA NA	23.08.90						
429	M	328	313	02.05.90	28.01.91	.094	N. CAROLINA	USA	02.05.90	FWS429	0429	SSP	34	36	9 M
							TACOMA	USA NA	20.11.90						
430	F	328	313	02.05.90	. .	.094	N. CAROLINA	USA	02.05.90	FWS430	0430	SSP	34	36	
							N. CAROLINA	USA NA	02.05.90						
431	M	212	297	04.05.90	. .	.125	TACOMA	USA	04.05.90	WG431	0431	SSP	94	48	
							TACOMA	USA NA	04.05.90						
432	M	212	297	04.05.90	. .	.125	TACOMA	USA	04.05.90	WG432	0432	SSP	94	48	
							TACOMA	USA NA	04.05.90						

RED WOLF (Canis rufus gregoryi)
Historical list of captive population
Printed on: 13.Feb.1991

Stbk #	Sex	Sire #	Dam #	Date of Birth	Date of Death	Inbr. Coeff.	First location / Location now		- arrived / - since	Breeder # Housename	Last ISIS	Mng Grp	Sire Age	Dam Age	Death Age
433	F	212	297	04.05.90	05.05.90	.125	TACOMA	USA	04.05.90	WG433	0433	SSP	94	48	1 D
							TACOMA	USA NA	04.05.90						
434	F	212	297	04.05.90	28.01.91	.125	TACOMA	USA	04.05.90	WG434	0434	SSP	94	48	9 M
							TACOMA	USA NA	04.05.90						
435	M	294	301	10.05.90	18.05.90	.070	TACOMA	USA	10.05.90	WG435	0435	SSP	46	48	8 D
							TACOMA	USA NA	10.05.90						
436	M	294	301	10.05.90	. .	.070	TACOMA	USA	10.05.90	WG436	0436	SSP	46	48	
							TACOMA	USA NA	10.05.90						
437	F	294	301	10.05.90	. .	.070	TACOMA	USA	10.05.90	WG437	0437	SSP	46	48	
							TACOMA	USA NA	10.05.90						
438	F	294	301	10.05.90	. .	.070	TACOMA	USA	10.05.90	WG438	0438	SSP	46	48	
							TACOMA	USA NA	10.05.90						
439	F	294	301	10.05.90	. .	.070	TACOMA	USA	10.05.90	WG439	0439	SSP	46	48	
							TACOMA	USA NA	10.05.90						
440	F	341	243	17.05.90	. .	.047	BEARDSLEY ZO	USA	17.05.90	DP440	0440	SSP	22	84	
							FOSSIL RIM	USA NA	22.01.91						
441	F	341	243	17.05.90	. .	.047	BEARDSLEY ZO	USA	17.05.90	DP441	0441	SSP	22	84	
							FOSSIL RIM	USA NA	22.01.91						
442	M	319	300	07.05.90	. .	.055	N. CAROLINA	USA	07.05.90	FWS442	0442	SSP	34	48	
							N. CAROLINA	USA NA	07.05.90						
443	F	319	300	07.05.90	. .	.055	N. CAROLINA	USA	07.05.90	FWS443	0443	SSP	34	48	
							N. CAROLINA	USA NA	07.05.90						
444	F	319	300	07.05.90	. .	.055	N. CAROLINA	USA	07.05.90	FWS444	0444	SSP	34	48	
							N. CAROLINA	USA	07.05.90						

Males - 183 Females - 214 Unknown - 47

PART IV

RECOVERY STRATEGY

A. Goal

Achieve a series of disjunct populations of red wolves, through reintroduction, that are numerically large enough to have the potential for allowing natural evolutionary processes to work within the species.

Objective No. 1: To preserve 80 to 90 percent genetic diversity of the species for 150 years.

Objective No. 2: To remove those threats that have the potential to bring about extinction of the species. Achieving this objective will require a wild population of approximately 220 animals and a captive population of approximately 330 animals.

Objective No. 3: To maintain the red wolf in perpetuity through cryogenic preservation of sperm and embryo banking.

B. Narrative

1. Coordinate and manage the red wolf recovery program. A full-time program coordinator is essential to maintain recovery direction and assure continuity of various objectives. The coordinator also provides leadership, establishes annual objectives and goals, develops budgetary needs, and serves as the spokesperson for the program.

2. Maintain a Red Wolf Recovery Team. A systematic biological review process is essential in a highly complex recovery effort. Periodic recovery team meetings are necessary to review progress and address special biological needs. The current team is composed of individuals with special skills and expertise applicable to the various objectives of this recovery plan.

3. Reestablish three or more wild populations totaling approximately 220 red wolves within the species' historic range. To preserve the genetic integrity of the species, it has been determined that at least three disjunct populations of red wolves will be needed. These discrete populations will have to maintain approximately 220 animals.

   3.1 Identify reintroduction sites. Potential sites must be carefully assessed. At the present time it appears that such sites must be in Federal ownership and contain at least 170,000 acres of contiguous habitat within the historic range of the red wolf.

      3.1.1 Through cursory field and literature examinations, develop a list of potential reintroduction sites and prioritize the list. This "wish list" should include all properties that meet the above criterion. Initially, national wildlife refuge system lands are to be preferred, followed by national park system properties. It is thought that Department of the Interior properties would offer greater opportunities for successfully carrying out a reintroduction project. This is predicated on basic land management objectives and mandates of the two agencies. A series of highly visible, successfully executed red wolf reintroductions on Department of the Interior lands would provide invaluable experience to project personnel and would build substantial program credibility. After several successful projects, other Federal lands might become available to the program. In addition, the potential of lease agreements on private lands will likely become a viable strategy in the future. In this context, utilizing private lands to connect otherwise disjunct and isolated populations could offer significant opportunities for achieving program goals. Combining Federal, State, and private properties into a wolf management zone could be made feasible by providing inducements such as tax incentives to participating property owners.

3.1.2 In priority order, examine potential reintroduction sites for essential biological parameters (prey abundance, habitat types, disease and parasites, etc), and socioeconomic factors (agricultural practices, land ownership patterns, proximity of towns and communities, etc.). In most instances basic biological studies of an area will have already been accomplished and data will be available, especially on Department of the Interior lands. Where not available, however, a biological base will have to be established. This may require conducting cursory field collecting exercises, habitat assessments, etc. Socioeconomic factors should be closely examined and potential problems with a major predator reintroduction realistically addressed early on. Only then can a strategy be developed to offset these problems.

3.1.3 Measure potential public response to a wolf reintroduction through selected contacts with knowledgeable field personnel at State, Federal, and national environmental organization level. Of great importance is the identification of certain key individuals in a potential project area. Time must be spent in explaining the rationale for such a project and in cultivating their support for a wolf reintroduction. The help of these individuals and organizations will later prove to be of immense value if the site is selected.

3.1.4 Estimate resident canid composition and density. Develop basic data base on resident canids. Surveys of trapping results, discussions with professional biologists and local hunters and trappers, and track examinations on selected dirt roads and trails will give a general idea of feral dog and coyote incidence. More definitive studies would involve systematic siren surveys and analyses of field-recorded vocalizations.

3.1.5 Develop and implement an experimental red wolf/coyote interaction study. A red wolf/coyote investigation has recently been initiated in the Great Smoky Mountains National Park. This study will examine home-range movement patterns of resident coyote populations. After 12 to 18 months of study, a carefully selected red wolf pair and their pups will be released into the study area after appropriate acclimation. Movements and interactions of wolves and coyotes will be monitored for a period of time. Released red wolves and subsequent offspring will be designated as experimental and nonessential and a special regulation so prepared. If possible, a second coyote/red wolf interaction investigation in a coastal plain habitat should be initiated. Results of these investigations should provide significant information for long-range planning purposes.

3.1.6 Develop a priority list of potentially feasible reintroduction sites. After a careful examination of available sites that meet definable criteria, certain sites will surface to the top of the list. The final selection will likely be based on certain key determinants such as geography, isolation, political considerations, etc.

3.1.7 Beginning with the most feasible site, coordinate a potential reintroduction project with appropriate Federal, State, and county officials and selected residents and landowners. Utilizing experience gained from the execution of Task 3.1.3, assess where to initiate this most important task. In some cases this will be at the local level, and in others it will be at the State or Federal political level. Up to 1 year of careful coordination may be required before a proposal is ready to enter into the public meeting phase.

3.1.8 Develop a detailed reintroduction technical proposal and necessary NEPA documents. A well-defined and readily understood technical document is of the utmost importance. This document must detail all aspects of a wolf reintroduction, including historic perspectives, facts about the red wolf, reintroduction goals, etc. A key section of great importance to local residents would relate to the effects of a wolf reintroduction. An environmental assessment should be drafted that assesses the proposal's impact on the local environment and economy.

3.1.9 Conduct public meetings; develop responsible media relationship. Great effort must be exercised in permitting the local public to express their concerns about the project. These forums provide the Service with the opportunity to present factual information about the red wolf and about the various components of the proposal. Much care must be directed at inviting appropriate State and county officials to these meetings. Enough meetings should be scheduled to fully allow public input. In dealing with the media, be factual and avoid speculation about the proposal.

3.1.10 Develop an experimental regulation tailored to the specific needs of the reintroduction site. Much attention should be given to the development of an experimental regulation as set forth under Section 10(j) of the Endangered Species Act. In addition to forming a legal basis for reintroduction of an otherwise endangered species, this regulation can also address local concerns and ideas brought forward at the public meetings. In essence, the regulation can be tailored to local situations and expressed needs so long as these needs do not undermine the objectives of the project. The draft regulation should also be developed in concert with local and national conservation organizations.

3.1.11 Construct necessary acclimation pens and purchase required equipment. As soon as funding is secured, public response is measured, and the proposal is acceptable to key State and Federal officials, work can proceed with the required pen construction and the purchase of the great variety of equipment required by a major mainland reintroduction project. The technical proposal developed under Task 3.1.8 will provide equipment needs.

3.2 Introduce red wolves. Animals should be shipped to the project site, placed in acclimation pens for approximately 6 months, and released.

3.2.1 Acclimate red wolves. During acclimation, animals should be fed native prey species and kept from human disturbance as much as possible; their homing instincts will be reoriented to the project site. To maximize productivity, it is wise to allow the adults to breed and have pups while in captive acclimation. Prior to release, adults and young should receive health checks and shots. New tracking collars should be fitted to adults and transmitters surgically implanted in pups.

3.2.2 Release red wolves. Timing of a wolf release should be carefully considered. The spring and summer part of the year is possibly best since an abundance of young, inexperienced prey species are generally available. Local conditions and project objectives will dictate the optimum time for release.

3.2.3 Monitor released wolves. Only the latest and most proven telemetry equipment should be utilized in a reintroduction project. Heavy emphasis must be given to tracking released animals during early stages of the project. Human/wolf interactions must be avoided, and only through a carefully conceived tracking program can this be minimized. As wolves settle into a routine, tracking schedules can be scaled back. Aircraft tracking has proven to be the most efficient method of monitoring red wolves.

3.2.4 Monitor prey species. Pre- and post-release prey surveys can be conducted if circumstances warrant. Such surveys, however, must be carefully designed if direct predator/prey relationships are to be demonstrated. The sensitivity of such surveys is critical and may prove to be beyond the capability of the project. Standard field techniques may suffice. Such techniques include wolf scat analyses and observational information, hunter kill records of key prey species, etc.

3.2.5 Assess success of reintroduction. Success can be measured in a variety of ways. The planner should spend time in defining this important point. It can be demonstrated in terms of biological parameters, but of possible equal importance is the concept of success as determined by public response and cooperation with a wolf reintroduction. Biological success may be easier to define, but in the long-term analysis, the human factor is of vital importance. Project personnel should strive to keep local residents aware of project status and solicit input from the public on important issues. Documentation of a successful (or unsuccessful) wolf reintroduction is of vital importance in planning future efforts.

4. Develop at least three red wolf propagation projects on suitable islands along the South Atlantic and Gulf Coasts and in suitable mainland enclosures. An integral component of the strategy to prevent genetic drift and infuse wildness into the red wolf program is to establish small island and mainland enclosure projects. These projects are envisioned strictly as propagation efforts and are adjuncts to mainland reintroductions. They will provide wild pups for either infusion into the captive-breeding program or for direct release into mainland projects. These projects also can serve to build public relations in select areas. Small fenced enclosures as small as 1 to 5 acres (.4 to 2 ha) can also serve as intermediate holding facilities for animals scheduled for release or for emergency holding purposes.

4.1 Identify potential propagation sites. Few islands along the South Atlantic and Gulf Coast offer the rigid requirements for a project of this nature. Ownership, acreage, prey base, and logistical support capability are all key criteria. It is thought that an island of at least 3,500 acres is needed to sustain an adult pair of red wolves and their offspring for a short period of time. Mainland enclosures will vary significantly, depending on circumstances relating to the size of the compound or enclosure.

4.1.1 Through cursory field and literature examinations, develop a list of potential propagation sites. Initially, attention should be limited to those islands within the species' historic range that are within the national wildlife refuge or national park systems. These islands must exhibit those general characteristics mentioned above in 4.1. Mainland propagation sites, on the other hand, may include existing enclosures such as surplus compounds on military facilities or abandoned U.S. Forest Service study enclosures. These will vary from site to site, but to fulfill project needs, such enclosures should be no less than 640 acres.

4.1.2 In priority order, examine potential propagation sites for essential biological parameters (prey abundance, habitat types, disease and parasites, etc.) and socioeconomic factors (agricultural practices, land use, proximity of towns and communities, etc.). In most instances, basic biological studies of an island situation will already be accomplished and data will be available, especially on Department of the Interior properties. Where an updating is required or basic information is not available, cursory field collecting exercises, habitat assessments, etc., will be required. Socioeconomic factors must be carefully considered. Public use of an island is a major consideration. It has been found that moderate public use, including hunting, should not automatically preclude an island from consideration. Mainland enclosures should only be considered if they are remote and/or well-secured sites. Prey availability is a major factor in such situations. If current biological data is not available, cursory surveys of these sites will be required.

4.1.3 Measure potential public response to a wolf propagation project through selected contacts, including knowledgeable personnel at the State and Federal level. Of great importance is the identification of certain key individuals who reside near a potential propagation site. Discussions with these individuals will usually yield invaluable clues regarding likely public reaction to a project. The help of these people will later prove to be of immense value if the site is selected for a project.

4.1.4 Estimate the resident canid population if an island project is under consideration. The presence of feral dogs and coyotes on an island will usually be readily evident from discussions with professional biologists, rangers, etc. If questions persist, examine tracks on dirt roads and beach areas. More definitive investigations would involve siren surveys.

4.1.5 Examine the compatibility of the propagation site ecosystem to the population of red wolves. The capability of a site to support red wolves and determining what impacts these predatory animals would have on resident fauna, especially species that are protected by State or Federal law, need evaluation. Include species of concern as well as species being considered for protection.

4.1.6 Develop a priority list of potentially feasible propagation sites. After a careful examination of available sites utilizing the definable criteria described above, certain sites will surface to the top of the list. The final selection will probably be resolved on the basis of ownership, security, geography, and political considerations.

4.1.7 Beginning with the most feasible propagation site, initiate formal coordination efforts with appropriate Federal, State, and county officials, as well as key residents, property owners, etc. Utilizing experience gained from the execution of Task 4.1.3, where to initiate this most important task should be assessed. In some cases this will be at the local level, and in others it will be at the State or Federal political level. Up to 1 year of careful planning may be necessary before the project is ready to enter into the public meeting stage.

4.1.8 Develop a detailed propagation proposal as well as necessary NEPA documents and a Section 7 evaluation. A well-defined, factual, and readily understood technical proposal is of the utmost importance. This document should detail all aspects of a red wolf propagation project, including historical information, facts about the red wolf, other projects and their status, project objectives, etc. A key section of great importance to any interested resident would relate to the project's ability to recapture any animal that should happen to escape. An environmental assessment and Section 7 evaluation would have to be completed by appropriate Service personnel.

4.1.9 Conduct public meetings if deemed necessary; develop a responsible media relationship. Service experience with red wolf projects indicates the public meeting process is of vital importance. If a propagation project is being attempted on another agency's property, however, that agency will have to make the determination to host a public meeting or not. If a public meeting is determined to be necessary, great effort must be exercised in developing a presentation that is fully factual. Provide time for the public to express their concerns and perceived fears. Generally, a project of this nature will be poorly understood by the public, even after extensive efforts are made to explain the project in the media, etc. In dealing with the media, present only factual information, not speculation.

4.1.10 Construct necessary acclimation pens and secure equipment needed for the project. As soon as public response is measured and funding is secured, the proposal should be formally accepted by key State and Federal officials. Work can proceed on construction of the acclimation pen (or the upgrade of an existing mainland enclosure), and the purchase of vital equipment can be initiated. The technical proposal developed under Task 4.1.8 will provide equipment needs.

4.2 Propagate red wolves. Captive-reared red wolves should be utilized in efforts to propagate wild offspring.

4.2.1 Acclimate red wolves. During the acclimation process on island situations, animals should be fed native prey species and be kept away from human contact as much as possible; their homing instincts will become reoriented to the project site. Temporary tracking collars should be fitted to each adult so the animals will be used to wearing these devices when released. Timing of the acclimation process should coincide with the breeding period and whelping of pups. Pups should be captured several weeks prior to release, and small transmitters should be surgically implanted into their abdominal cavities.

4.2.2 Release red wolf family unit into island situation. Due to techniques employed in the acclimation process, animals should normally be released by mid-July. This also coincides with prey species' being at high levels. Supplemental feeding may be required in some situations and will vary from project to project.

4.2.3 Monitor released family units on island sites. Intensity of monitoring will vary from island to island, depending on geographic features and specific objectives of each project. In situations where animals could reach the mainland by swimming narrow water barriers, tracking frequency should have to be at maximum levels, especially during early phases of the project. On most island sites, tracking can be accomplished on foot, by vehicle, or from a boat.

4.2.4 Monitor prey species on island sites. Both pre- and post-project prey surveys can be conducted if circumstances warrant. Such surveys, however, must be carefully designed if direct predator/prey relationships are to be demonstrated. The sensitivity of such surveys is critical and may prove to be beyond the capability of the project. Standard field techniques may suffice. Such techniques include wolf scat analysis and observational information, hunter kill records of key prey species, etc.

4.2.5 If a mainland captive project is initiated, monitor adults and capture offspring at 8 to 10 months of age. Mainland propagation projects probably don't lend themselves as well to the rearing of wild pups as islands do. This relates to the relatively small size of typical enclosures. Some military compounds, however, could be of sufficient size to allow natural processes to function. These processes are, of course, related to typical predator/prey relationships. The degree of wildness that could be expected from pups so acclimated is yet to be determined. When such opportunities arise, the program should address this potential technique. Animals in enclosures could be monitored utilizing the same techniques mentioned in Task 4.2.4.

4.2.6 Capture island-born offspring at 7 to 8 months of age. Since this propagation strategy involves the use of offspring with implant tracking transmitters, retrieval of these young animals at 7 to 8 months of age is greatly simplified. At this time, adults should also be caught and placed back in pens for a new cycle of breeding and pup rearing. Experiences to date indicate that the island animals can be recaptured by baiting them back into the acclimation pen.

5. Additional land acquisition on Service properties.

5.1 Secure, by fee acquisition or long-term lease agreements, properties adjacent to or within the proximity of Alligator River National Wildlife Refuge, North Carolina. Such additions would significantly enhance the effectiveness of this major project for the benefit of the red wolf. When and if other national wildlife refuge system lands serve as future red wolf reintroduction sites, such land acquisitions and leases should be encouraged.

6. Develop captive-breeding facilities capable of providing animals for reintroduction purposes as well as safeguarding the genetic integrity of the species.

   6.1 Expand and maintain captive-breeding capability to accommodate 330 red wolves. The Service contract with the Point Defiance Zoo was expanded significantly in fiscal year 1989. This increase in funding will permit a twofold increase in the Point Defiance Zoo project facility and also substantially expand the number of participating public and private zoos in the United States to hold red wolves.

   6.2 Maintain the integrity of brood stock through continued implementation of a breeding program with the AAZPA. The Service should cooperate with AAZPA to ensure that the red wolf studbook is accurately maintained. Service recovery planning should be integrated with AAZPA SSP formulation. This will ensure that suitable numbers of red wolves are available for reintroduction and propagation projects. This cooperative effort should also facilitate selection of red wolf recipients and ensure that participating zoos and facilities adhere strictly to established regulations and protocols.

   6.3 Initiate red wolf genetic investigations. Contract with a recognized authority to utilize state-of-the-art biochemical techniques to address the issue of red wolf speciation.

7. Develop a strategy for the cryogenic preservation of red wolf sperm and embryo banking.

   7.1 Develop protocols for F_1 generation sperm and embryo banking utilizing cryogenic techniques. Significant advances in long-term storage of embryos and sperm in bovids have been accomplished in recent years. Little work has been attempted with canids. To ensure the preservation of critical red wolf genetic material, specific protocols for the collection and long-term storage of sperm and embryos should be developed.

   7.2 Contract with an appropriate facility to maintain genetic material. The Service should contract this aspect of the recovery effort.

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PART ~~III~~ V

IMPLEMENTATION SCHEDULE

Priorities in column one of the following implementation schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

AAZPA - American Association of Zoological Parks and Aquariums
FS - U.S. Forest Service
FWS - U.S. Fish and Wildlife Service
FWE - Fish and Wildlife Enhancement (Division of FWS)
NPS - National Park Service
PDZ - Point Defiance Zoo, Tacoma, Washington
TNC - The Nature Conservancy

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS						
				Region	Program	Other	FY 1990	FY 1991	FY 1992	
1	1.0	Coordinate and manage the red wolf recovery program.	Ongoing	4	FWE		67	62	62	
3	2.0	Maintain a Red Wolf Recovery Team.	Ongoing	4	FWE		6	4.5	4.5	
2	3.1.1	List potential reintroduction sites.	Ongoing	4	FWE		2	.5	.5	
2	3.1.2	In priority order, examine potential reintroduction sites.	4 years	4	FWE	NPS, FS	2	1	1	
2	3.1.3	Measure potential public response to a wolf reintroduction.	4 years	4	FWE	NPS, FS	2	2	2	
2	3.1.4	Estimate resident canid composition and density.	4 years	4	FWE	NPS, FS	2	1	1	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY FWS Region	FWS Program	Other	COST ESTIMATES ($000'S) FY 1990	FY 1991	FY 1992	COMMENTS
2	3.1.5	Develop experimental red wolf/ coyote interaction study.	3 years	4	FWE	NPS, FS	30	40	20	Contract investigation.
2	3.1.6	Develop priority list of reintroduction sites.	4 years	4	FWE		-0-	-0-	-0-	
2	3.1.7	Coordinate potential wolf reintroduction project.	Ongoing	4	FWE		3	2	1	
2	3.1.8	Develop a detailed reintroduction proposal.	Ongoing	4	FWE	NPS, FS	2	2	2	
2	3.1.9	Conduct public meetings.	Ongoing	4	FWE	NPS, FS	-0-	2	2	
2	3.1.10	Develop experimental regulation.	Ongoing	4	FWE	NPS, FS	1	.5	.5	
2	3.1.11	Construct acclimation pens; purchase equipment.	Ongoing	4	FWE	NPS, FS	20	20	65	
2	3.2.1	Acclimate red wolves.	Ongoing	4	FWE	NPS, FS	30	40	50	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY: FWS Region	RESPONSIBLE PARTY: FWS Program	RESPONSIBLE PARTY: Other	COST ESTIMATES ($000'S): FY 1990	COST ESTIMATES ($000'S): FY 1991	COST ESTIMATES ($000'S): FY 1992	COMMENTS
2	3.2.2	Release red wolves.	Ongoing	4	FWE		-0-	-0-	-0-	
2	3.2.3	Monitor released wolves.	Ongoing	4	FWE	NPS, FS	167	230	330	
3	3.2.4	Monitor prey species.	Ongoing	4	FWE	NPS, FS	-0-	20	20	
2	3.2.5	Assess reintroduction.	Ongoing	4	FWE	NPS, FS	2	-0-	-0-	
3	4.1.1	Develop a list of potential propagation sites.	1 year	4	FWE		-0-	-0-	-0-	
3	4.1.2	In priority order, examine potential propagation sites.	5 years	4	FWE		2	.5	.5	
3	4.1.3	Measure potential public response to a propagation project.	5 years	4	FWE	NPS, FS	2	.5	.5	
3	4.1.4	Estimate resident canid population.	5 years	4	FWE	NPS, FS	1	.5	.5	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY: FWS Region	RESPONSIBLE PARTY: FWS Program	RESPONSIBLE PARTY: Other	COST ESTIMATES ($000'S): FY 1990	COST ESTIMATES ($000'S): FY 1991	COST ESTIMATES ($000'S): FY 1992	COMMENTS
3	4.1.5	Examine compatibility of propagation site ecosystem to a small red wolf population.	5 years	4	FWE	NPS, FS	4.6	.5	.5	
3	4.1.6	Develop priority list of propagation sites.	2 years	4	FWE		1	-0-	-0-	
3	4.1.7	Coordinate potential propagation projects.	Ongoing	4	FWE		1	1	1	
3	4.1.8	Develop a detailed propagation proposal.	Ongoing	4	FWE		2	.5	.5	
3	4.1.9	Conduct public meetings if necessary.	Ongoing	4	FWE	NPS, FS	-0-	1	1	
3	4.1.10	Construct acclimation pens; purchase equipment.	Ongoing	4	FWE	NPS	5	5	5	
3	4.2.1	Acclimate red wolves.	Ongoing	4	FWE	NPS	10	15	15	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY: FWS Region	RESPONSIBLE PARTY: FWS Program	RESPONSIBLE PARTY: Other	COST ESTIMATES ($000'S): FY 1990	COST ESTIMATES ($000'S): FY 1991	COST ESTIMATES ($000'S): FY 1992	COMMENTS
3	4.2.2	Release red wolves.	Ongoing	4	FWE	NPS	-0-	-0-	-0-	
3	4.2.3	Monitor released wolves.	Ongoing	4	FWE	NPS	5	23	25	
3	4.2.4	Monitor prey species on island sites.	Ongoing	4	FWE	See *1	15	-0-	-0-	Non-Federal funding.
3	4.2.5	If mainland project, monitor adults and capture pups at 8 to 9 months of age.	Ongoing	4	FWE	FS, and see *2	-0-	-0-	-0-	Mainland propagation projects scheduled for later years.
3	4.2.6	Capture island-born pups at 8 to 9 months of age.	Ongoing	4	FWE	NPS	2	2	3	
3	5.1	Additional land acquisitions.	Ongoing	4	FWE	TNC	-0-	-0-	-0-	
1	6.1	Expand captive-breeding capability.	5 years	4	FWE	PDZ	160	218	280	FWS contract.
2	6.2	Implement breeding program with AAZPA.	5 years	4	FWE	PDZ	2	-0-	-0-	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY FWS Region	FWS Program	Other	COST ESTIMATES ($000'S) FY 1990	FY 1991	FY 1992	COMMENTS
3	6.3	Fund red wolf genetic investigation.	2 years	4	FWE	PDZ	25	10	-0-	
3	7.1	Develop protocols for sperm and embryo banking.	4 years	4	FWE	PDZ	10	5	5	FWS contract.
3	7.2	Contract cryogenic facility for preservation of genetic materials.	Ongoing	4	FWE	PDZ	3	5	15	FWS contract.

*1 - Other agencies' responsibilities would be of a cooperative nature or projects would be funded under a contract or grant program. In some cases contracts could be let to universities or private enterprises.

*2 - Military facilities.

Implementation Schedule Cost Information

1. Cost information set forth in this schedule is for planning purposes only. This aspect of the recovery plan will be refined through agency budget processes as new studies and/or management information dictates.

2. Initiation of some tasks is dependent on the completion and/or results of others. Therefore, target dates for some activities may require adjustments over time. Negotiations and planning for major reintroduction projects with Federal land management agencies may involve considerable time and effort. Reintroduction schedules presented in this plan are therefore subject to substantial variability.

RED WOLF RECOVERY PLAN FUNDING SUMMARY

FY 1 (Current Funding)	Funds Needed (In Thousands)	
	FY 2	FY 3
$445.0	$673.5	$948.5

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